ROYAL SOCIETY OF NEW SOUTH WALES.

A

JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

FOR

1885.

INCORPORATED 1881.

VOL. XIX.

EDITED BY

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Professor of Chemistry and Mineralogy in the University of Sydney.

THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE STATEMENTS MADE AND THE OPINIONS EXPRESSED THEREIN.

AGENTS FOR THE SOCIETY:

Messrs. Trübner & Co., 57, Ludgate Hill, London, E.C.

SYDNEY: THOMAS RICHARDS, GOVERNMENT PRINTER.

1886.

NOTICE.

The Royal Society of New South Wales originated in 1821 as the "Philosophical Society of Australasia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; in 1866, by the sanction of Her Most Gracious Majesty the Queen, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

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VOLUME XIX.

The Royal Society of New South Wales.

OFFICERS FOR 1885-86.

HONORARY PRESIDENT:

HIS EXCELLENCY THE RT. HON. LORD AUGUSTUS LOFTUS,
G.C.B., &c., &c., &c.

PRESIDENT:

PROFESSOR LIVERSIDGE, F.R.S., F.C.S., F.G.S., &c.

VICE-PRESIDENTS:

HON. PROF. SMITH, C.M.G., M.D., M.L.C., &c. *Obiit* 12 Oct., 1885.
H. G. A. WRIGHT, M.R.C.S., *Eng.*, L.S.A., *Lond.*

HONORARY TREASURER:

ROBERT HUNT, F.G.S., &c.

HONORARY SECRETARIES:

DR. ADOLPH LEIBIUS, M.A., F.C.S.

W. CAMAC WILKINSON, M.D., M.R.C.P., *Lond.*, M.R.C.S.E., M.L.A.

COUNCIL:

MACKELLAR, HON. C. K., M.L.C., A.M., M.B.
MOORE, CHARLES, F.L.S.
PEDLEY, P. R.
ROLLESTON, CHR., C.M.G.
RUSSELL, H. C., B.A., F.R.A.S., &c.
WILKINSON, C.S., F.G.S., F.L.S.

ASSISTANT SECRETARY:

W. H. WEBB.

ROYAL SOCIETY OF NEW SOUTH WALES INCORPORATION.

An Act to incorporate a Society called "The Royal Society of New South Wales." [16 December, 1881.]

WHEREAS a Society called (with the sanction of Her Most Gracious Majesty the Queen) "The Royal Society of New South Wales" has under certain rules and by-laws been formed at Sydney in the Colony of New South Wales for the encouragement of studies and investigations in Science Art Literature and Philosophy And whereas the Council of the said Society is at the present time composed of the following office-bearers and members His Excellency the Right Honorable Lord Augustus Loftus P.C. G.C.B. Honorary President The Honorable John Smith C.M.G. M.D. LL.D. President and Charles Moore Esquire F.L.S. Director of the Botanic Gardens Sydney and Henry Chamberlaine Russell Esquire B.A. (Sydney) F.R.A.S. F.M.S. London Government Astronomer for New South Wales Vice-Presidents and H. G. A. Wright Esquire M.R.C.S. Honorary Treasurer Archibald Liversidge Esquire Associate of the Royal School of Mines London Fellow of the Institute of Chemistry of Great Britain and Ireland and Professor of Geology and Mineralogy in the University of Sydney and Carl Adolph Leibius Esquire Doctor of Philosophy of the University of Heidelberg Fellow of the Institute of Chemistry of Great Britain and Ireland Honorary Secretaries W. A. Dixon Fellow of the Institute of Chemistry of Great Britain and Ireland G. D. Hirst Esquire Robert Hunt Esquire Associate of the Royal School of Mines London Deputy Master Sydney Branch Royal Mint Eliezer L. Montefiore Esquire Christopher Rolleston Esquire C.M.G. Preamble.

Charles Smith Wilkinson Esquire Government Geologist Members of the Council And whereas it is expedient that the said Society should be incorporated and should be invested with the powers and authorities hereinafter contained Be it therefore enacted by the Queen's Most Excellent Majesty by and with the advice and consent of the Legislative Council and Legislative Assembly of New South Wales in Parliament assembled and by the authority of the same as follows:—

Interpretation clause.

1. For the purposes of this Act the following words in inverted commas shall unless the context otherwise indicate bear the meaning set against them respectively—

"Corporation" the Society hereby incorporated

"Council" the Members of the Council at any duly convened meeting thereof at which a quorum according to the by-laws at the time being shall be present

"Secretary" such person or either one of such persons who shall for the time being be the Secretary or Secretaries honorary or otherwise of the said Society (saving and excepting any Assistant Secretary of the said Society).

Incorporation clause.

2. The Honorary President the President Vice-Presidents Officers and Members of the said Society for the time being and all persons who shall in manner provided by the rules and by-laws for the time being of the said Society become members thereof shall be for the purposes hereinafter mentioned a body corporate by the name or style of "The Royal Society of New South Wales" and by that name shall and may have perpetual succession and a common seal and shall and may enter into contracts and sue and be sued plead and be impleaded answer and be answered unto defend and be defended in all Courts and places whatsoever and may prefer lay and prosecute any indictment information and prosecution against any person whomsoever and any summons or other writ and any notice or other proceeding which it may be requisite to serve upon the Corporation may be served upon the Secretary or one of the Secretaries as the case may be or if there be no Secretary or if the Secretaries or Secretary be absent from the Colony then upon the President or either of the Vice-Presidents.

Rules and by-laws.

3. The present rules and by-laws of the said Society shall be deemed and considered to be and shall be the rules and by-laws of the said Corporation save and except in so far as any of them are or shall or may be altered varied or repealed under the powers for that purpose therein contained or are

or may be inconsistent or incompatible with or repugnant to any of the provisions of this Act or any of the laws now or hereafter to be in force in the said Colony.

Power to acquire and hold and to sell lands &c.

4. The Corporation shall have power to purchase acquire and hold lands and any interest therein and also to sell and dispose of the said lands or any interest therein and all lands tenements hereditaments and other property of whatever nature now belonging to the said Society under the said rules and by-laws or vested in Trustees for them shall on the passing of this Act be vested in and become the property of the said Corporation subject to all charges claims and demands in anywise affecting the same.

Ordinary business to be managed by the Council.

5. The ordinary business of the Corporation in reference to its property shall be managed by the Council and it shall not be lawful for individual members to interfere in any way in the management of the affairs of the Corporation except as by the rules and by-laws for the time being shall be specially provided.

Powers of Council.

6. The Council shall have the general management and superintendence of the affairs of the Corporation and excepting the appointment of President and Vice-Presidents and other honorary officers who shall be appointed as the by-laws of the Society shall from time to time provide the Council shall have the appointment of all officers and servants required for carrying out the purposes of the Society and of preserving its property and it may also define the duties and fix the salaries of all officers Provided that if a vacancy shall occur in the Council during any current year of the Society's proceedings it shall be lawful for the Council to elect a member of the Society to fill such vacancy for the unexpired portion of the then current year The Council may also purchase or rent land houses or offices and erect buildings or other structures for any of the purposes for which the Society is hereby incorporated and may borrow money for the purposes of the Corporation on mortgages of the real and chattel property of the Corporation or any part thereof or may borrow money without security provided that the amount so borrowed without security shall never exceed in the aggregate the amount of the income of the Corporation for the last preceding year and the Council may also settle and agree to the covenants powers and authorities to be contained in the securities aforesaid.

Liability of members.

7. In the event of the funds and property of the Corporation being insufficient to meet its engagements each member thereof shall in addition to his subscription for the

then current year be liable to contribute a sum equal thereto towards the payment of such engagements but shall not be otherwise individually liable for the same and no member who shall have commuted his annual subscription shall be so liable for any amount beyond that of one year's subscription.

Custody of common seal.

8. The Council shall have the custody of the common seal of the Corporation and have power to use the same in the affairs and business of the Corporation and for the execution of any of the securities aforesaid and may under such seal authorize any person without such seal to execute any deed or deeds and do such other matter as may be required to be done on behalf of the Corporation but it shall not be necessary to use the said seal in respect of the ordinary business of the Corporation nor for the appointment of their Secretaries Solicitor or other officers.

Certified copy of rules and by-laws to be evidence.

9. The production of a printed or written copy of the rules and by-laws of the Corporation certified in writing by the Secretary or one of the Secretaries as the case may be to be a true copy and having the common seal of the Corporation affixed thereto shall be conclusive evidence in all Courts of such rules and by-laws and of the same having been made under the authority of this Act.

Elections not made in due time may be made subsequently.

10. In case any of the elections directed by the rules and by-laws for the time being of the Corporation to be made shall not be made at the times required it shall nevertheless be competent to the Council or to the members as the case may be to make such elections respectively at any ordinary meeting of the Council or at any annual or special general meeting held subsequently.

Secretary may represent Corporation for certain purposes.

11. The Secretary or either one of the Secretaries may represent the Corporation in all legal and equitable proceedings and may for and on behalf of the Corporation make such affidavits and do such acts and sign such documents as are or may be required to be done by the plaintiff or complainant or defendant respectively in any proceedings to which the Corporation may be parties.

INDEX TO RULES.

RULES.

(Revised October 1st, 1879.)

Additional Rules adopted November 5th, 1884, marked thus, XA, *&c.*

Object of the Society.

I. The object of the Society is to receive at its stated meetings original papers on Science, Art, Literature, and Philosophy, and especially on such subjects as tend to develop the resources of Australia, and to illustrate its Natural History and Productions.

Honorary President.

II. The Governor of New South Wales shall be *ex officio* Honorary President of the Society.

Other Officers.

III. The other Officers of the Society shall consist of a President, who shall hold office for one year only, but shall be eligible for re-election after the lapse of one year; two Vice-Presidents, a Treasurer, and one or more Secretaries, who, with six other members, shall constitute a Council for the management of the affairs of the Society.

Election of Officers and Council.

IV. The President, Vice-Presidents, Secretaries, Treasurer, and the six other members of Council, shall be elected annually by ballot at the General Meeting in the month of May.

V. It shall be the duty of the Council each year to prepare a list containing the names of members whom they recommend for election to the respective offices of President, Vice-Presidents, Hon. Secretaries and Hon. Treasurer, together with the names of six other members whom they recommend for election as ordinary members of Council.

The names thus recommended shall be proposed at one meeting of the Council, and agreed to at a subsequent meeting.

Such list shall be suspended in the Society's Rooms, and a copy shall be sent to each ordinary member not less than fourteen days before the day appointed for the Annual General Meeting.

VA. There shall be elected on to the Council for each ensuing year, at least two and not more than three members of the Society who were not members of the Council for the previous year.

VI. Each member present at the Annual General Meeting shall have the power to alter the list of names recommended by the Council, by adding to it the names of any eligible members not already included in it and removing from it an equivalent number of names, and he shall use this list with or without such alterations as a balloting list at the election of Officers and Council.

The name of each member voting shall be entered into a book, kept for that purpose, by two Scrutineers elected by the members present.

No ballot for the election of members of Council, or of new members, shall be valid unless twenty members at least shall record their votes.

Vacancies in the Council during the year.

VII. Any vacancies occurring in the Council of Management during the year may be filled up by the Council.

Candidates for admission.

VIII. Candidates must be at least twenty-one years of age.

Every candidate for admission as an ordinary member of the Society shall be recommended according to a prescribed form of certificate by not less than three members, to two of whom the candidate must be personally known.

Such certificate must set forth the names, place of residence, and qualifications of the candidate.

The certificate shall be read at the three Ordinary General Meetings of the Society next ensuing after its receipt, and

during the intervals between those three meetings, it shall be suspended in a conspicuous place in one of the rooms of the Society.

The vote as to admission shall take place by ballot, at the Ordinary General Meeting at which the certificate is appointed to be read the third time, and immediately after such reading.

At the ballot the assent of at least four-fifths of the members voting shall be requisite for the admission of the candidate.

Entrance Fee and Subscriptions.

IX. The entrance money paid by members on their admission shall be Two Guineas; and the annual subscription shall be Two Guineas, payable in advance; but members elected prior to December, 1879, shall be required to pay an annual subscription of One Guinea only as heretofore.

The amount of ten annual payments may be paid at any time as a life composition for the ordinary annual payment.

IXA. The entrance fee and first annual subscription shall be paid within two months from the date of election; otherwise the election shall be void.

The Council may, however, in special cases, extend the period within which these payments must be made.

IXB. Composition fees shall be treated as capital, and shall be devoted to the Building Fund Account, or invested.

New Members to be informed of their election.

X. Every new member shall receive due notification of his election, and be supplied with a copy of the obligation (No. 3 in Appendix), together with a copy of the Rules of the Society, a list of members, and a card of the dates of meeting.

Members shall sign Rules—Formal admission.

XI. Every member who has complied with the preceding Rules shall at the first Ordinary General Meeting at which he shall be present sign a duplicate of the aforesaid obligation in a

book to be kept for that purpose, after which he shall be presented by some member to the Chairman, who, addressing him by name, shall say:—"In the name of the Royal Society of New South Wales I admit you a member thereof."

Annual subscriptions, when due.

XII. Annual subscriptions shall become due on the 1st of May for the year then commencing. The entrance fee and first year's subscription of a new member shall become due on the day of his election.

XIIA. Persons elected on or after the first day of October in any year shall pay the annual contribution as in advance for the following year, but in every case within two months after notification of their election has been made to them by the Honorary Secretary.

Members whose subscriptions are unpaid not to enjoy privileges.

XIII. An elected member shall not be entitled to attend the meetings or to enjoy any privilege of the Society, nor shall his name be printed in the list of the Society, until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself.

Subscriptions in arrears.

XIV. Members who have not paid their subscriptions for the current year, on or before the 31st of May, shall be informed of the fact by the Hon. Treasurer.

No member shall be entitled to vote or hold office while his subscription for the previous year remains unpaid.

The name of any member who shall be two years in arrears with his subscriptions shall be erased from the list of members, but such member may be re-admitted on giving a satisfactory explanation to the Council, and on payment of arrears.

At the meeting held in July, and at all subsequent meetings for the year, a list of the names of all those members who are in

arrears with their annual subscriptions shall be suspended in the Rooms of the Society. Members shall in such cases be informed that their names have been thus posted.

XIVA. Any member in arrears shall cease to receive the Society's publications, and shall not be entitled to any of the privileges of the Society until such arrears are paid.

Resignation of Members.

XV. Members who wish to resign their membership of the Society are requested to give notice in writing to the Honorary Secretaries, and are required to return all books or other property belonging to the Society.

Expulsion of Members.

XVI. A majority of members present at any ordinary meeting shall have power to expel an obnoxious member from the Society, provided that a resolution to that effect has been moved and seconded at the previous ordinary meeting, and that due notice of the same has been sent in writing to the member in question, within a week after the meeting at which such resolution has been brought forward.

Honorary Members.

XVII. The Honorary Members of the Society shall be persons who have been eminent benefactors to this or some other of the Australian Colonies, and distinguished patrons and promoters of the objects of the Society. Every person proposed as an Honorary Member must be recommended by the Council and elected by the Society. Honorary Members shall be exempted from payment of fees and contributions: they may attend the meetings of the Society, and they shall be furnished with copies of the publications of the Society, but they shall have no right to hold office, to vote, or otherwise interfere in the business of the Society.

The number of Honorary Members shall not at any one time exceed twenty, and not more than two Honorary Members shall be elected in any one year.

Corresponding Members.

XVIII. Corresponding Members shall be persons, not resident in New South Wales, of eminent scientific attainments, who may have furnished papers or otherwise promoted the objects of the Society.

Corresponding Members shall be recommended by the Council, and be balloted for in the same manner as ordinary Members.

Corresponding Members shall possess the same privileges only as Honorary Members.

The number of Corresponding Members shall not exceed twenty-five, and not more than three shall be elected in any one year.

Ordinary General Meetings.

XIX. An Ordinary General Meeting of the Royal Society, to be convened by public advertisement, shall take place at 8 p.m., on the first Wednesday in every month, during the last eight months of the year; subject to alteration by the Council with due notice.

Order of Business.

XX. At the Ordinary General Meetings the business shall be transacted in the following order, unless the Chairman specially decide otherwise:—

1—Minutes of the preceding Meeting.
2—New Members to enrol their names and be introduced.
3—Ballot for the election of new Members.
4—Candidates for membership to be proposed.
5—Business arising out of Minutes.
6—Communications from the Council.
7—Communications from the Sections.
8—Donations to be laid on the Table and acknowledged.
9—Correspondence to be read.
10—Motions from last Meeting.
11—Notices of Motion for the next Meeting to be given in.
12—Papers to be read.
13—Discussion.
14—Notice of Papers for the next Meeting.

XXA. At the ordinary meetings of the Society nothing relating to its regulations or management, except as regards the election or ejection of members, shall be brought forward, unless the same shall have been announced in the notice calling the meeting, or be otherwise provided for in these Rules.

XXB. A special meeting of the Society may be called by the Council, provided that seven days notice be given by advertisement, or shall be so called on a requisition signed by at least twenty-five members of the Society, to consider any special business thus notified.

Annual General Meeting.—Annual Reports.

XXI. A General Meeting of the Society shall be held annually in May, to receive a Report from the Council on the state of the Society, and to elect Officers for the ensuing year. The Treasurer shall also at this meeting present the annual financial statement.

Admission of Visitors.

XXII. Every ordinary member shall have the privilege of introducing two friends as visitors to an Ordinary General Meeting of the Society or its Sections, on the following conditions :—

1. That the name and residence of the visitors, together with the name of the member introducing them, be entered in a book at the time.
2. That they shall not have attended two consecutive meetings of the Society or of any of its Sections in the current year.

The Council shall have power to introduce visitors irrespective of the above restrictions.

Council Meetings.

XXIII. Meetings of the Council of Management shall take place on the last Wednesday in every month, and on such other days as the Council may determine.

XXIIIA. The President or Hon. Secretaries, or any three Members of the Council, may call a meeting of the Council, provided that due notice of the same has been sent to each Member of the Council at least three days before such meeting.

Absence from Meetings of Council.—Quorum.

XXIV. Any member of the Council absenting himself from three consecutive meetings of the Council, without giving a satisfactory explanation in writing, shall be considered to have vacated his office. No business shall be transacted at any meeting of the Council unless three members at least are present.

Duties of Secretaries.

XXV. The Honorary Secretaries shall perform, or shall cause the Assistant Secretary to perform, the following duties :—

1. Conduct the correspondence of the Society and Council.
2. Attend the General Meetings of the Society and the meetings of the Council, to take minutes of the proceedings of such meetings, and at the commencement of such to read aloud the minutes of the preceding meeting.
3. At the Ordinary Meetings of the members, to announce the presents made to the Society since their last meeting; to read the certificates of candidates for admission to the Society, and such original papers communicated to the Society as are not read by their respective authors, and the letters addressed to it.
4. To make abstracts of the papers read at the Ordinary General Meetings, to be inserted in the Minutes and printed in the Proceedings.
5. To edit the Transactions of the Society, and to superintend the making of an Index for the same.
6. To be responsible for the arrangement and safe custody of the books, maps, plans, specimens, and other property of the Society.

7. To make an entry of all books, maps, plans, pamphlets, &c., in the Library Catalogue, and of all presentations to the Society in the Donation Book.
8. To keep an account of the issue and return of books, &c., borrowed by members of the Society, and to see that the borrower, in every case, signs for the same in the Library Book.
9. To address to every person elected into the Society a printed copy of the Forms Nos. 2 and 3 (in the Appendix), together with a list of the members, a copy of the Rules, and a card of the dates of meeting; and to acknowledge all donations made to the Society, by Form No. 6.
10. To cause due notice to be given of all Meetings of the Society and Council.
11. To be in attendance at 4 p.m. on the afternoon of Wednesday in each week during the session.
12. To keep a list of the attendances of the members of the Council at the Council Meetings and at the ordinary General Meetings, in order that the same may be laid before the Society at the Annual General Meeting held in the month of May.

The Honorary Secretaries shall, by mutual agreement, divide the performance of the duties above enumerated.

The Honorary Secretaries shall, by virtue of their office, be members of all Committees appointed by the Council.

Contributions to the Society.

XXVI. Contributions to the Society, of whatever character, must be sent to one of the Secretaries, to be laid before the Council of Management. It will be the duty of the Council to arrange for promulgation and discussion at an Ordinary Meeting such communications as are suitable for that purpose, as well as to dispose of the whole in the manner best adapted to promote the objects of the Society.

XXVIA. The original copy of every paper communicated to the Society, with the illustrative drawings, shall become the property of the Society unless stipulation be made to the contrary; and authors shall not be at liberty, save by permission of the Council, to publish the papers they have communicated, until such papers or abstracts of them, have appeared in the Journal or other publications of the Society.

XXVIB. If any paper of importance is communicated during the recess, the same may be ordered for publication by the Council, without being read to the Society.

Management of Funds.

XXVII. The funds of the Society shall be lodged at a Bank named by the Council of Management. Claims against the Society, when approved by the Council, shall be paid by the Treasurer.

All cheques shall be countersigned by a member of the Council.

*Money Grants.**

XXVIII. Grants of money in aid of scientific purposes from the funds of the Society—to Sections or to members—shall expire on the 1st of November in each year. Such grants, if not expended, may be re-voted.

XXIX. Such grants of money to Committees and individual members shall not be used to defray any personal expenses which a member may incur.

Audit of Accounts.

XXX. Two Auditors shall be appointed annually, at an Ordinary Meeting, to audit the Treasurer's Accounts. The accounts as audited to be laid before the Annual Meeting in May.

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* Applicants for money grants are required to supply the following information :—

1. The nature of the research and the scientific results expected to follow therefrom.
2. The amount asked for.
3. Whether any previous grant has been received from any source, and, if so, with what results.
4. Whether any portion of the grant is to be devoted to personal remuneration
5. What apparatus (if any) of permanent value will be required.

Property of the Society to be vested in the President, &c.

XXXI. All property whatever belonging to the Society shall be vested in the President, Vice-Presidents, Hon. Treasurer, and Hon. Secretaries for the time being, in trust for the use of the Society; but the Council shall have control over the disbursements of the funds and the management of the property of the Society.

SECTIONS.

XXXII. To allow those members of the Society who devote attention to particular branches of science fuller opportunities and facilities of meeting and working together with fewer formal restrictions than are necessary at the general Monthly Meetings of the Society,—Sections or Committees may be established in the following branches of science:—

Section A.—Astronomy, Meteorology, Physics, Mathematics, and Mechanics.

Section B.—Chemistry and Mineralogy, and their application to the Arts and Agriculture.

Section C.—Geology and Palæontology.

Section D.—Biology, *i.e.*, Botany and Zoology, including Entomology.

Section E.—Microscopical Science.

Section F.—Geography and Ethnology.

Section G.—Literature and the Fine Arts, including Architecture.

Section H.—Medical.

Section I.—Sanitary and Social Science and Statistics.

Section Committees—Card of Meetings.

XXXIII. The first meeting of each Section shall be appointed by the Council. At that meeting the members shall elect their own Chairman, Secretary, and a Committee of four; and arrange the days and hours of their future meetings. A card showing the dates of each meeting for the current year shall be printed for distribution amongst the members of the Society.

Membership of Sections.

XXXIV. Only members of the Society shall have the privilege of joining any of the Sections.

Reports from Sections.

XXXV. There shall be for each Section a Chairman to preside at the meetings, and a Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Hon. Secretaries of the Society, on or before the 7th of December in each year, a report of the proceedings of the Section during that year, in order that the same may be transmitted to the Council.

Reports.

XXXVI. It shall be the duty of the President, Vice-Presidents, and Honorary Secretaries to annually examine into and report to the Council upon the state of—

1. The Society's house and effects.
2. The keeping of the official books and correspondence.
3. The library, including maps and drawings.
4. The Society's cabinets and collections.

Cabinets and Collections.

XXXVII. The keepers of the Society's cabinets and collections shall give a list of the contents, and report upon the condition of the same to the Council annually.

Documents.

XXXVIII. The Honorary Secretaries and Honorary Treasurer shall see that all documents relating to the Society's property, the obligations given by members, the policies of insurance, and other securities shall be lodged in the Society's iron chest, the contents of which shall be inspected by the Council once in every year; a list of such contents shall be kept, and such list shall be signed by the President or one of the Vice-Presidents at the annual inspection.

Branch Societies.

XXXIX. The Society shall have power to form Branch Societies in other parts of the Colony.

Library.

XL. The members of the Society shall have access to, and shall be entitled to borrow books from the Library, under such regulations as the Council may think necessary.

Alteration of Rules.

XLI. No alteration of, or addition to, the Rules of the Society shall be made unless carried at two successive General Meetings, at each of which twenty-five members at least must be present.

THE LIBRARY.

1. The Library shall be open for consultation and for the issue and return of books daily (except Saturday), between 1·30 and 6 p.m., and on Saturdays from 9 a.m. to 1·30 p.m.; also, on the evenings of Monday, Wednesday, and Friday, from 7 to 10 p.m.

1A. The Library will not be open on public holidays.

2. No book shall be issued without being signed for in the Library Book.

3. Members are not allowed to have more than two volumes at a time from the Library, without special permission from one of the Honorary Secretaries, nor to retain a book for a longer period than fourteen days; but when a book is returned by a member it may be borrowed by him again, provided it has not been bespoken by any other member. Books which have been bespoken shall circulate in rotation, according to priority of application.

4. Scientific Periodicals and Journals will not be lent until the volumes are completed and bound.

4A. Dictionaries, Encyclopædias, and other works of reference and cost, Atlases, Books and Illustrations in loose sheets, Drawings, Prints and unbound numbers of Periodicals and Works, Journals, Transactions and Proceedings of Societies or Institutions, Works of a Series, Maps or Charts, are not to be removed from the Library without the written order of the President or one of the Hon. Secretaries.

5. Members retaining books longer than the time specified shall be subject to a fine of sixpence per week for each volume.

6. The books which have been issued shall be called in by the Secretaries twice a year; and in the event of any book not being returned on those occasions, the member to whom it was issued shall be answerable for it, and shall be required to defray the cost of replacing the same.

7. No stranger shall be admitted to the Library except by the introduction of a member, whose name, together with that of the visitor, shall be inserted in a book kept for that purpose.

8. Members shall not lay the paper upon which they are writing on any Book or Map.

No tracings shall be made without express permission from the Hon. Secretaries.

Form No. 1.

ROYAL SOCIETY OF NEW SOUTH WALES.

Certificate of a Candidate for Election.

Name

Qualification or occupation

Address

being desirous of admission into the Royal Society of New South Wales, we, the undersigned members of the Society, propose and recommend him as a proper person to become a member thereof.

Dated this day of 18 .

FROM PERSONAL KNOWLEDGE.	FROM GENERAL KNOWLEDGE.

Signature of candidate

Date received 18 .

N.B.—This certificate must be signed by three or more members, to two of whom the candidate must be personally known. The candidate must be at least twenty-one years of age. This certificate has to be read at three ordinary general meetings of the Society.

Form No. 2.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,

Sir, Sydney, 18 .

I have the honour to inform you that you have this day been elected a member of the Royal Society of New South Wales, and I beg to forward to you a copy of the Rules of the Society, a printed copy of an obligation, a list of members, and a card announcing the dates of meeting during the present session.

According to the Regulations of the Society (*vide* Rule No. 9), you are required to pay your admission fee of two guineas, and annual subscription of two guineas for the current year, before admission. You are also requested to sign and return the enclosed form of obligation at your earliest convenience.

I have, &c.,

To Hon. Secretary.

Form No. 3.

ROYAL SOCIETY OF NEW SOUTH WALES.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of New South Wales, and to observe its Rules and By-laws, as long as I shall remain a member thereof.

Signed,

Address

Date

Form No. 4.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,

Sir, Sydney, 18 .

I have the honour to inform you that your annual subscription of for the current year became due to the Royal Society of New South Wales on the 1st of May last.

It is requested that payment may be made by cheque or Post Office order drawn in favour of the Hon. Treasurer.

I have, &c.,

To Hon. Treasurer.

Form No. 5.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,

Sir, Sydney, 18 .

I am desired by the Royal Society of New South Wales to forward to you a copy of its Journal for the year 18 , as a donation to the library of your Society.

I am further requested to mention that the Society will be thankful to receive such of the very valuable publications issued by your Society as it may feel disposed to send.

I have the honour to be,
Sir,
Your most obedient servant,

Hon. Secretary.

Form No. 6.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's House,

Sir, Sydney, 18 .

On behalf of the Royal Society of New South Wales, I beg to acknowledge the receipt of and I am directed to convey to you the best thanks of the Society for your most valuable donation.

I have the honour to be,
Sir,
Your most obedient servant,

Hon. Secretary.

Form No. 7.

Balloting List for the Election of the Officers and Council.

ROYAL SOCIETY OF NEW SOUTH WALES.

Date.......................

BALLOTING LIST for the election of the Officers and Council.

Present Council.	Names proposed as Members of the new Council.	
	President.	
	Vice-Presidents.	
	Hon. Treasurer.	
	Hon. Secretaries.	
	Members of Council.	

If you wish to substitute any other name in place of that proposed, erase the printed name in the second column, and write opposite to it, in the third, that which you wish to substitute.

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal; papers published in the Transactions of the Philosophical Society are also included. The numerals indicate the number of such contributions.
† Members of the Council.
‡ Life Members.

Elected.		
1877		Abbott, Joseph Palmer, M.L.A., 6 Wentworth Court, Elizabeth-street.
1877	P 1	Abbott, Thomas Kingsmill, S.M., Central Police Office, Sydney.
1877	P 3	Abbott, W. E., Abbotsford, Wingen.
1877		Adams, Francis, A.J.S. Bank, Sydney.
1864		Adams, P. F., Surveyor General, Kirribilli Point, St. Leonards.
1878		Alexander, George M., 48, Margaret-street.
1874		Alger, John, Macquarie-street.
1868		Allerding, F., Hunter-street.
1873		Allerding, H. R., Hunter-street.
1856		Allwood, Rev. Canon, B.A. *Cantab.*, "Rorklands," Edgecliff Road, Woollahra.
1885		Allworth, Joseph Witter, District Surveyor, East Maitland.
1881		Amos, Robert, "Renneil," Elizabeth Bay Road.
1877		Anderson, H. C. L., M.A., "Aberfeldie," Summer Hill.
1876		Atchison, Cunningham Archibald, C.E., North Shore.
1873		Atherton, Ebenezer, M.R.C.S. *Eng.*, Macquarie-street.
1882		Atkinson, J. J. O., J. P., Oldbury, Moss Vale.
1885		Baas, James Ranson, C.E., 10, Rockwall-street, Potts's Point.
1878		Backhouse, Alfred P., M.A., District Court Judge, "Melita," Elizabeth Bay.
1877		Baker, E. A., M.L.A., Erith Colliery, Bundanoon.
1878		Balfour, James, The Oriental Bank, Pitt-street.
1881		Barff, H. E., M.A., Registrar, Sydney University.
1878		Barker, Francis Lindsay, Pitt-street.
1879		Barraclough, William, Donnelly-street, Balmain.
1884		Barry, The Most Rev. Dr. A., D.D., D.C.L., Primate, Bishops-court, Randwick.
1875		Bartels, W. C. W., Richmond Terrace.
1876		Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.

Elected.		
1878		Bayley, George W. A., Railway Department, Phillip-street.
1884		Baynes, Richd. B., Victoria Barracks.
1875		Bedford, W. J. G., M.R.C.S. *Eng.*, "Waratah," Newtown, Hobart, Tasmania.
1868		Beilby, E. T., 91, Pitt-street.
1875		Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, 60, Castlereagh-street.
1877		Belfield, Algernon H., "Eversleigh," Armidale.
1875		Belisario, John, M.D., Lyons' Terrace.
1876		Benbow, Clement A., 30, College-street.
1869	P 2	Bensusan, S. L., 44, Castlereagh-street.
1877		Bennett, George F., C.M.Z.S., Toowoomba, Queensland.
1878		Berney, Augustus, H. M. Customs, Sydney.
1878		Bestic, Edwin Henry, L.R.C.S., *Irel.*, L.R.C.P., *Edin.*, Phillip-street.
1884		Binstead, Wm. H. Glenthorne, Boulevard, Petersham.
1878		Black, Reginald James, Union Club.
1878		Black, Morrice A., F.I.A., Actuary, Australian Mutual Provident Society, Pitt-street.
1880		Blackmann, C. H. E., 375, George-street.
1877		Bladen, Thomas, 205½, Victoria-street.
1883		Blaxland, Herbert, M.R.C.S.E., L.R.C.P. *Lond.*, Hospital for the Insane, Callan Park.
1872		Bolding, H. J., P.M., Narrabri.
1879		‡Bond, Albert, Bell's Chambers, Pitt-street.
1874		Bowen, George M. C., "Keston," Kirribilli Point, North Shore.
1876		Brady, Andrew John, Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, 3, Lyons' Terrace.
1871	P 1	Brazier, John, C.M.Z.S., Corr. M.R.S., Tas., 82, Windmill-street.
1868		Brereton, John Le Gay, M.D. *St. Andrew's*, L.R.C.S. *Edin.*, Domain Terrace.
1879		Brindley, Thomas, St. Stephen's House, Bligh-street, Newtown.
1876		Brodribb, W. A., The Hon., M.L.C, F.R.G.S., 133, Macquarie-street.
1878		‡Brooks, Joseph, F.R.G.S., "Hope Bank," Nelson-st., Woollahra.
1876		Brown, Henry Joseph, Newcastle.
1880		Brown, John Studd, Dubbo.
1876		Brown, Thomas, "Rockleigh," Edward-street, North Shore.
1882		Bullock, Chas. Cyrus, 2, Euroka Terrace, St. Leonards.
1877		Bundock, W. C., "Wyangarie," Casino.
1877		Burnell, Arthur, "Clapton," Forbes-street.
1875		Burton, Edmund, Land Titles Office, Elizabeth-street North.
1875		Busby, The Hon. William, M.L.C., "Redleaf," South Head Road, Woollahra.
1880		Bush, Thomas James, Engineer's Office, Gas Works, Sydney.
1876		Cadell, Alfred, Vegetable Creek, New England.
1876		Cadell, Hon. Thomas, M.L.C., Australian Club.
1880		Caird, George S., "Lillingstone," Ocean-street, Woollahra.
1876		Campbell, Allan, L.R.C.P., *Glasgow*, Yass.
1876		Campbell, The Hon. Alexander, M.L.C., "Rosemont," Woollahra.
1868		Campbell, The Hon. Charles, M.L.C., "Clunes," South Kingston.

Elected.		
1879		Cameron, John, Geodetic Surveyor, Trig. Branch, Surveyor-General's Office.
1879		Campbell, Revd. Joseph, M.A., "The Parsonage," Glen Innes.
1870		Cane, Alfred, 110, Victoria-street.
1876		Cape, Alfred J., M.A., *Syd.*, "Karoola," Edgecliff Road.
1882		Carruthers, Chas. Ulic, L.K.Q.C.P., L.R.C.S., *Irel.*, Montague-street, Balmain.
1885		Chadwick, Robert, "Arlington," Edgecliff Road, Woollahra.
1876		Chandler, Alfred, "Wambiana," Homebush.
1882		Chambers, Thos., F.R.C.P., F.R.C.S. *Edin.*, 1. Lyons' Terrace.
1879	P 1	‡Chard, J. S., District Surveyor, Armidale.
1878		Chatfield, Captn. William, Smith-street, Parramatta.
1884		Chesterman, Alfd. Hy., L.S., Surveyor General's Office.
1878		Chisholm, Edwin, M.R.C.S., E., L.S.A., &c., "Abergeldie," Ashfield.
1885		Chisholm, William, M.D., *Lond.*, 199, Macquarie-street North.
1876		Codrington, John Fredk., M.R.C.S., E.; Lic. R.C. Phys., L.; Lic. R.C. Phys., *Edin.*, Orange.
1878		Collie, Revd. Robert, F.L.S., "The Manse," Wellington-street, Newtown.
1878		Colquhoun, George, "Rossdhu," Darlinghurst Road.
1880		Colyer, Henry Cox, M.A., "Clinton," Liverpool-street, Darlinghurst.
1876		Colyer, John Ussher Cox, A.S.N. Company, Sydney.
1856		Comrie, James, "Northfield," Kurrajong Heights.
1876		Conder, Wm., Chairman, Local Land Board, Cooma.
1882		Conlan, George Nugent, F.R.G.S., care of Mr. C. E. Riddell, Union Club.
1882		Copeland, H. P. R., S.W.S. Camp, Narellan.
1882		Cornwell, Samuel, junr., Kent Brewery, Sydney.
1878		Cottee, Wm. Alfred, 2, Spring-street.
1880		Cox, The Hon. George Henry, M.L.C., "Winbourn," Penrith.
1859	P 1	Cox, James, M.D. *Edin.* C.M.Z.S., F.L.S., 73, Hunter-street.
1884	P 1	Cox, Saml. Herbert, F.C.S., F.G.S., 1 Victoria Terrace, Miller-street, North Shore.
1865	P 2	Cracknell, E. C., Superintendent of Telegraphs, Telegraph Office, George-street.
1869		Creed, The Hon. J. Mildred, M.L.C., M.R.C.S. *Eng.*, L.R.C.P., *Edin.*, Woollahra.
1870		Croudace, Thomas, Lambton.
1881		Crummer, Henry, 47, Rialto Terrace, Darlinghurst.
1877		Cunningham, Andrew, Lanyon, Queanbeyan.
1885		Dalton, James Neale, Head Master, The Queen's School, Sydney.
1873		Daintrey, Edwin, "Æolia," Randwick.
1876		Dansey, George Frederick, M.R.C.S. *London*, 329, Cleveland-street, Redfern.
1875		Dangar, Frederick H., "Grantham," Potts's Point.
1876		Darley, Cecil West, "Erinagh," Elizabeth Bay Road.
1877		Darley, Hon. F. M., M.L.C., B.A., Wentworth Court, Elizabeth-street.
1879		Davenport, Sir Samuel, K.C.M.G., "Beaumont," Adelaide, South Australia.

Elected.		
1878		Dean, Alexander, J.P., 54 Castlereagh-street.
1885		Deane, Henry, C.E., Gladesville.
1877		Deck, John Field, M.D., Ashfield.
1856		Deffell, George H., Chief Commissioner, Insolvency Court, Phillip-street.
1881		Delarue, Leopold H., 378, George-street.
1875		De Salis, The Hon. Leopold Fane, M.L.C., "Tharwa," Queanbeyan.
1876		Dight, Arthur, Richmond.
1875	P 9	Dixon, W. A., F.C.S., Fellow and Member Inst. of Chemistry of Gt. Britain and Irel., Lecturer on Chemistry, The Technical College, School of Arts, Pitt-street, Sydney.
1882		Dixon, Fletcher, English, Scottish, and Australian Chartered Bank, George-street.
1880		Dixson, Craig, M.B., C.M., *Edin.*, M.R.C.S., *Eng.*, M.D. *Syd.*, 2, Clarendon Terrace, Elizabeth-street.
1880		Dixson, Thomas, M.B., Mast. Surg., *Edin.*, "Ellalong," Ashfield.
1876		Docker, Ernest B., M.A. *Sydn.*, "Carhullen," Granville.
1879		Docker, Wilfred L., "Nyrambla," Darlinghurst Road.
1882		Donkin, J. B., The Exchange, Sydney.
1876		Douglas, James, L.R.C.S. *Edin.*, 3, Hope Terrace, Glebe Road.
1879		Dowling, Neville, "Brougham," Wallis-street, Woollahra.
1884		Dowling, Edward, "Warung," Blue's Point, North Shore.
1876		Drake, William Hedley, Fellow of the Inst. of Bankers, Lond., Colonial Bank of New Zealand, Napier, N.Z.
1873		Du Faur, Eccleston, F.R.G.S., "Marfa," Croydon.
1876		Eales, Hon. John, M.L.C., Duckenfield Park, Morpeth.
1876		Egan, Myles, M.R.C.S. *Eng.*, 136, Elizabeth-street.
1874		Eichler, Charles F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, Bridge-street.
1876		Eldred, W. H., 62, Margaret-street.
1881		Elliott, F. W., Elizabeth Bay.
1885		Ellis, Henry A., M.B., Ch. B. Univ. *Dub.*, 3, Bayswater Houses, Double Bay.
1876		Evans, George, "Como," Darling Point.
1881		Evans, Thomas, M.R.C.S., *E.*, 211, Macquarie-street North.
1881		Ewan, John Frazer, M.B., Mast. Surg. Univ. *Edin.*, Carlton Terrace, Wynyard Square.
1877		Fairfax, Edward R., 145, Macquarie-street.
1868		Fairfax, James R., *Herald* Office, Hunter-street.
1880		Ferguson, J. W., 70, Darlinghurst Road.
1881		Fiaschi, Thos., M.D., M. Ch., Univ. Pisa, 39, Phillip-street.
1876		Firth, Rev. Frank, Wesleyan Parsonage, Waverley.
1874		Fischer, Carl F., M.D., M.R.C.S., *Eng.*; L.R.C.P., *Lond.*; F.G.S.; F.L.S.; F.R.M.S.; Member Imp. Botanical and Zoological Society, Vienna; Corr. Member Imp. Geographical Society, Vienna.
1876		Fitzgerald, R. D., F.L.S., Deputy-Surveyor-General, Sydney.

Elected.		
1856		Flavelle, John, 340, George-street.
1880		Forbes, Alexr. Leith, M.A.. Dept. of Public Instruction.
1879		‡Foreman, Joseph, M.R.C.S., L.R.C.P., *Edin.*, 161, Macquarie-street.
1881		Foster, W. J., M.L.A., Temple Court, King-street.
1878		Fraser, Robert, Vickery's Buildings, 80A, Pitt-street.
1882		Fraser, Rev. John G., M.A., Warden of Camden College.
1883	P 1	Fraser, John, B.A., *Edin.*, Délégué Général (pour l'Océanie), de l'Institution Ethnographique de Paris, Associate of the Victoria (Philosophical) Institute of Great Britain, c/o Rev. James Benvie, Manse, West Maitland.
1881		Furber, T. F., "Clifton," Burwood.
1880		Gardiner, Rev. Andrew, M.A., Glebe Point.
1884		Gardiner, John, Chief Examiner, Department of Public Instruction, Harrow Road, Stanmore, Petersham.
1877		Garnsey, Rev. C. F., Christ Church Parsonage, Sydney.
1868	P 1	Garran, Andrew, LL.D., *Sydney Morning Herald* Office, Hunter-street.
1883		Garrett, H. Edwd., M.R.C.S.E., 37, Wynard Square West.
1877		Garvan, J. P., M.L.A., East St. Leonards.
1878		Gedye, Charles Townsend, "Eastbourne," Darling Point.
1878		George, Hugh, *Sydney Morning Herald* Office.
1876		George, W. R., 346, George-street.
1879		Gerard, Francis, Crown Lands Office.
1884		Gibbs, J. Burton, 70, Pitt-street North.
1876		Gilchrist, W. O., "Greenknowes," Potts's Point.
1884		Gill, Rev. Wm. Wyatt, B.A., *Lond.*, "Persica," Illawarra Road, Marrickville.
1876	P 2	Gipps, F. B., C.E., "Maida," Chandos-street, Ashfield.
1878		Goddard, William C., The Exchange, New Pitt-street.
1881		Goergs, Karl W., Riviere College, Woollahra.
1876		Goode, George, M.A., M.D., M. Ch., Trin. Coll., *Dub.*, Enfield House, Camden.
1883		Goode, Wm. Hy., M.A., M.D., Ch.M., Diplomate in State Medicine, *Dub.*, Surgeon Royal Navy, Corres. Mem. Royal Dublin Society, Mem. Brit. Med. Assoc., Lecturer on Medical Jurisprudence, University of Sydney, 159, Macquarie-street North.
1859		Goodlet, John H., George-street.
1876		Grahame, Hon. Wm., M.L.C., Stratheam House, Waverley.
1885		Griffin, Gilderoy Wells, Consul for the United States of America, 12, Beresford Chambers, Castlereagh-street.
1881		Griffin, T. H. F., Commercial Bank, Richmond.
1878		Griffiths, Frederick C., Spring-street, "Greenknowe," 56, Macleay-street.
1877		Griffiths, G. Neville, The Domain, Sydney.
1877		Gurney, T. T., M.A. *Cantab.*, late Fellow of St. John's College, Cambridge, Professor of Mathematics and Natural Philosophy, University of Sydney.

Elected.		
1880		Haege, Hermann, 93, Pitt-street.
1878		Hall, Richard T., "Thornton," Upper William-street.
1880		Halligan, Gerald H., C.E., "Eugowra," Hunter's Hill.
1882		Hammond, Mark J., M.L.A., Ashfield.
1882		Hankins, Geo. Thos., M.R.C.S.E., Liverpool-street, Hyde Park.
1877	P 3	Hargrave, Lawrence, 1, Macleay Villas, Rushcutter's Bay Road.
1881		‡Harris, John, M.L.A., "Bulwarra," Jones-street, Ultimo.
1877		‡Harrison, L. M., Macquarie Place.
1878	P 2	Hart, Ludovico, c/o Messrs. Hart & Curtis, "Avenel," High-street, St. Kilda.
1884		Haswell, William Aitcheson, M.A., B.Sc., Demonstrator of Comparative Anatomy and Physiology, University of Sydney Australian Club.
1877	P 1	Hawkins, H. S., M.A., Balmain.
1874		Hay, The Hon. Sir John, K.C.M.G., M.L.C., A.M. *Aberdeen*, President of the Legislative Council, Rose Bay, Woollahra.
1876		Heaton, J. H., M.P., St. Stephen's Club, Westminster, London.
1881		Helms, Albert, Ph. D., *Berlin*, Sydney University.
1877		Henry, James, 750, George-street.
1884		Henson, Joshua B., C.E., Assistant City Engineer, Town Hall, Sydney.
1878		Herborn, E. W. L., "Flinton," Burwood.
1878		Herborn, Eugene, Licensed Surveyor, Bathurst.
1876		Heron, Henry, solicitor, 53, Hunter-street.
1876		Hewett, Thomas Edward, Technical College, Sydney.
1879		Higgins, R. G., "Clifford," Potts's Point.
1879		Hills, Robert, Elizabeth Bay.
1879		Hitchins, Edwd. Lytton, "Florence," Victoria-street North, Darlinghurst.
1876	P 2	Hirst, Geo. D., 377, George-street.
1882		Hoff, August (changed name from Duckershoff) M.D. Univ. *Leipzig*, 197, Liverpool-street.
1876		Holroyd, Arthur Todd, M.B. *Cantab.*, M.D. *Edin.*, F.L.S., F.Z.S., F.R.G.S., Sherwood Scrubs, Parramatta.
1870		Horton, Rev. Thomas, Ina Terrace, Woollahra.
1879		Houison, Andrew, B.A., M.B., C.M., *Edin.*, 128, Phillip-street.
1877		Hume, J. K., "Beulah," Campbelltown.
1878		†Hunt, Robert, F.G.S., Deputy Master of the Royal Mint, Sydney, *Hon. Treasurer*.
1882		Hurst, George, M.B., Univ. *Lond.*, Mast. Surg. Univ. *Edin.*, 28, College-street, Hyde Park.
1879		Inglis, James, M.L.A., "Craigo," Redmyre.
1880		Iredale, Lancelot, A.F., Goolhi, Gunnedah.
1878		Jackson, Arthur Levett, Government Printing Office.
1876		Jackson, Henry Willan, M.R.C.S. *Eng.*, Lic. R. C. Phys., *Edin.*, 146, Phillip-street.
1885		Jackson, Rev. H. L., M.A. (Cantab.), St. James's Parsonage, Macquarie-street.
1879		Jarvie, Rev. A. Milne, Univ. Council, *Edin.*, Manse, Jamieson-street.

Elected.		
1879		Jefferis, Rev. James, LL.B., "The Retreat," Newtown.
1884		Jenkins, Edward Johnstone, M.A., M.B., *Oxon*, M.R.C.P., M.R.C.S., L.S.A., *Lond.*, Prince Alfred Hospital.
1879		Johnson, James W., "Brooksby," Double Bay.
1876		Jones, James Aberdeen, Lic. R.C. Phys. *Edin.*, Booth-street Balmain.
1876		Jones, Richard Theophilus, M.D. *Sydn.*, L.R.C.P. *Edin.*, "Caer Idris," Ashfield.
1867		Jones, P. Sydney, M.D. *Lond.*, F.R.C.S. *Eng.*, College-street.
1877		Jones, Edward Lloyd, 349, George-street, Sydney.
1874		Jones, James, Bathurst-street.
1879		Jones, John Trevor, C.E., North Shore.
1884		Jones, Llewellyn Chas. Russell, 33, Castlereagh-street.
1863		Josephson, Joshua Frey, F.G.S., Bellevue Hill, Double Bay.
1876	P 2	Josephson, J. P., Assoc. Mem. Inst. C.E., George-street, Marrickville.
1878		Joubert, Numa, Hunter's Hill.
1883		Kater, H. E., "Mount Broughton," Moss Vale.
1873		Keele, Thos. Wm., Harbours and Rivers Department, Phillip-street.
1877		Keep, John, "Broughton," Leichhardt.
1884		Kendall, Theodore M., B.A., F.R.C.S., F.R.C.P., F.M., 36, College-street, Hyde Park.
1874		King, Hon. Philip G., M.L.C., "Banksia," William-street, Double Bay.
1878		Knaggs, Saml. T., M.D., 16, College-street.
1881	P 1	Knibbs, G. H., Trig. Branch, Surveyor-General's Office.
1874		Knox, George, M.A., *Cantab.*, Phillip-street.
1875		Knox, Edward, The Hon., M.L.C., O'Connell-street.
1877		Knox, Edward W., "Lansdowne," Darling Point.
1877		Kopsch, G., 8, Boulevard, Petersham.
1878		Kyngdon, F. B., 221, Darlinghurst Road.
1878		Kyngdon, Fred. H., M.D. *Aberdeen*; L.S.A., *L.*; M.R.C.S., *E.*; C.M., *Aberdeen*, "Altona," North Shore.
1884		Kyngdon, Boughton, L.S.A., Medl. Assoc. King's Coll. *Lond.*, 69, Darlinghurst Road.
1884		Lackey, The Hon. John, M.L.C., Union Club.
1883		Lane, Willm. H. H., 6, Bligh-street.
1874	P 1	Latta, G. J., "Hawthorne," Crystal-street, Petersham.
1876		Laure, Louis Thos., M.D. Surg. Univ. *Paris*, 138, Castlereagh-street.
1859	P 6	†Leibius, Adolph, Ph.D., Heidelberg, M.A., F.C.S.; Senior Assayer to the Sydney Branch of the Royal Mint, *Hon. Secretary*.
1885		Lendenfeld, Dr. R. von, "Glenburn," High-street, North Shore.
1885		Leverrier, Frank, B.A., B.Sc., "Tarnagulla," Waverley.
1874		Lenehan, Henry Alfred, Sydney Observatory.
1883		Lingen, J. T., M.A. *Cantab.*, 101, Elizabeth-street.

Elected.		
1883		Little, Wm., L.R.C.P., L.R.C.S. *Edin.*, Burwood.
1872	P 24	†Liversidge, Archibald, F.R.S.; Assoc. Roy. Sch. Mines, *Lond.*; F.C.S.; Fel. Inst. Chemistry of Gt. Brit. and Irl.; F.G.S.; F.L.S.; F.R.G.S.; Mem. Phy. Soc. London; Mem. Mineralogical Soc. Gt. Brit. and Irel.; Cor. Mem. Roy. Soc. Tas.; Cor. Mem. Senckenberg Institute, Frankfurt; Cor. Mem. Soc. d'Acclimat. Mauritius; Hon. Fel. Roy. Hist. Soc. Lond.; Mem. Min. Soc. of France; Professor of Chemistry and Mineralogy in the University of Sydney, *President*. The University, Glebe.
1874		Lloyd, George Alfred, F.R.G.S., M.L.A., "Scottforth," Elizabeth Bay.
1881		Lloyd, Lancelot T., "Eurotah," William-street East.
1879		Loftus, His Excellency The Right Hon. Lord Augustus, G.C.B. &c., &c., &c., *Hon. President.*
1876		Lord, The Hon. Francis, M.L.C., North Shore.
1882		Lovell, R. Haynes, M.R.C.S., L.R.C.P., *Lond.*, 26, Wynward Sq.
1878		Low, Hamilton, H.M. Customs.
1880		Low, Andrew S., "Merrylands," Granville.
1881		Lowe, Edwin, Wilgar Downs Station, *via* Girilambone.
1884		MacCormick Alexr., M.D., M.B., Ch.M. *Edin.*, M.R.C.S.E., Demonstrator of Anatomy, University of Sydney.
1876		M'Culloch, A. H., jun., M.L.A., 121, Pitt-street.
1874		M'Cutcheon, John Warner, Assayer to the Sydney Branch of the Royal Mint.
1878		MacDonald, Ebenezer, "Woerden," Cambridge-street, Stanmore.
1868		MacDonnell, William J., F.R.A.S., Bank of New South Wales, Port Macquarie.
1877		MacDonnell, Samuel, 312, George-street, Sydney.
1882		MacGillivray, P. H., M.A., M.R.C.S., F.L.S., Sandhurst, Victoria.
1876		M'Kay, Dr., Belmont House, Wynyard Square.
1880	P 1	M'Kinney, Hugh G., Assoc. Mem. Inst. C.E., Athenæum Club, Hunter-street.
1876		MacLaurin, Henry Norman, M.A., M.D. Univ. *Edin.*, Lic. R. Coll. Sur. *Edin.*, No. 155, Macquarie-street.
1878	P 4	‡MacPherson, Rev. Peter, M.A., 187, Albion-street, Sydney.
1872		Mackenzie, John, F.G.S., Examiner of Coal Fields, Newcastle.
1874		Mackenzie, W. F., M.R.C.S., L.R.C.P. *Edin.*, *Eng.*, Lyons' Terrace.
1876		Mackenzie, Rev. P. F., "Sydenham," Reserve-street, North Annandale.
1880		Mackenzie, R. M., Bond-street.
1884		Mackenzie, John Bower, M.I.C.E., Engineer's Office, Government Dockyard, Biloela, Sydney.
1876		†Mackellar, The Hon. Chas. Kinnard, M.L.C., A.M., M.B., C.M., *Glas.*, Macquarie-street.
1882		Madsen, Hans. F., "Hesselmed" House, Queen-street, Newtown.
1885		Maher, W. Odillo, M.D., Queen's Univ. *Irel.*, 20, College-street, Hyde Park.
1883		Maiden, Josh. Hy., Technological Museum, Sydney.

Elected.		
1878		Maitland, Duncan Mearns, "Afreba," Stanmore Road.
1873		Makin, G. E., Berrima.
1880		Manfred, Edmund C., Montague-street, Goulburn.
1877		Mann, John F., "Kerepunu," Neutral Bay.
1881		Manning, Sir W. M., LL.D., Primary Judge, "Walleroy," Edgecliff Road, Woollahra.
1873	P 6	Manning, James, "Beulah," Milson's Point, North Shore.
1876		Manning, Frederic Norton, M.D. Univ. *St. And.*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Hunter's Hill.
1869		Mansfield, G.A., 121, Pitt-street.
1880		Marano, G. V., M.D. Univ. *Naples*, Clarendon Terrace, Elizabeth-street.
1878		Markey, James, L.R.C.S., *Irel.*, L.R.C. Phys., *Edin.*, Regent-street.
1885		Marks, James Surfleet, The City Bank, Sydney.
1872		Marsden, The Right Rev. Dr., Bishop of Bathurst, Bathurst.
1876		Marshall, George, M.D. Univ. *Glas.*, Lic. R. Coll. S. *Edin.*, Lyons' Terrace.
1879		Masters, Edward, "Lurlei," Marrickville.
1875		Mathews, R. H., J.P., L.S., Singleton.
1879		Matthews, Robert, Tumut-street, Adelong.
1879		Meslée, E. Marin de la, Surveyor-General's Office.
1873		Milford, F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, 3, Clarendon Terrace, Hyde Park.
1876		Millard, Rev. Henry Shaw, Newcastle Grammar School.
1885		Miller, Wm. Valentine, C.E., Bach. Eng. Q.U.I, Box 923, G.P.O., Sydney.
1884		Mills, Walter Wallace, East-street, Marrickville.
1882		Milson, Alfred G., East St. Leonards.
1882		Milson, James, "Elamang," North Shore.
1875		Moir, James, 58, Margaret-street.
1875		Montefiore, E. L., Darlinghurst.
1850	P 5	†Moore, Charles, F.L.S., Director of the Botanic Gardens, Botanic Gardens.
1879		Moore, Fred. H., Exchange Buildings.
1883		Morley, Frederick, 47, Surry-street, Darlinghurst.
1865	P 1	Morrell, G. A., C.E., 156, Pitt-street.
1877	P 1	Morris, William, Fel. Fac. Phys. and Surg. *Glas.*, F.R.M.S. Lond., 53, Castlereagh-street, *Vice-President*.
1880		Moses, David, J.P., Tenterfield.
1882		Moss, Sydney, 5, Hunter-street.
1879		Mountain, Adrian C., City Surveyor, Town Hall.
1877		‡Mullens, Josiah, F.R.G.S., Eldon Chambers, Pitt-street.
1879		Mullins, John Francis Lane, M.A., 2 Macleay Heights, Potts's Point.
1885		Munro, Andrew Watson, M.B., C.M., 5 Carlton Terrace, Wynyard Square.
1865		Murnin, M. E., "Eisenfels," Nattai.
1876		‡Murray, W. G., 93, Pitt-street.
1876		Myles, Chas. Henry, "Dingadee," Burwood.

Elected		
1873		Neill, William, City Bank, Pitt-street.
1874		Neill, A. L. P., City Bank, Pitt-street.
1885		Newbery, William, M.A. (Cantab.), Sydney Grammar School.
1881		Newton, Dr. J. L., Mudgee.
1882		Norrie, Andrew, M.D., Mast. Surg., *Aberdeen* Univ., 171, Liverpool-street, Hyde Park.
1873		Norton, James, Hon., M.L.C., solicitor, O'Connell-street.
1875		Nott, Thomas, M.D. *Aberdeen*, M.R.C.S. *Eng.*, Ocean-street, Woollahra.
1878		Nowlan, John, "Eelah," West Maitland.

1879		O'Connor, Dr. Maurice, 26, College-street, Hyde Park.
1881		O'Connor, Richd. Edwd., M.A., Wentworth Court, Elizabeth-street.
1878		Ogilvy, James L., Commercial Bank of Australia, Pitt-street, Sydney.
1883		Oram, Arthur Murray, M.D., Univ. *Edin.*, Liverpool-street, Hyde Park.
1875		O'Reilly, W. W. J., M.D., M.C., Q. Univ. *Irel.*, M.R.C.S., *Eng.*, Liverpool-street.
1882		O'Reilly, Rev. Alexr. Innes, B.A., *Cantab.*, Hayfield, Parramatta.
1883		Osborne, Benjn. M., J.P., Berrima.

1885		Park, Archd. John, Chairman, Local Land Board, Hay.
1880		Paling, W. H., 356, George-street.
1875		Palmer, J. H., Legislative Assembly.
1880		Palmer, Joseph, 133, Pitt-street.
1882	P 1	Palmer, Edward (M.L.A., Queensland), c/o Messrs. B. D. Morehead & Co., Brisbane.
1876		Parrott, Major Thomas S., C.E., 56, Arcade, King-street.
1878		Paterson, Hugh, 229, Macquarie-street.
1877		Paterson, James A., Union Bank, Pitt-street.
1878		Paterson, Alexander, M.D., M.A., "Hillcrest," Stanmore Road.
1877		†Pedley, Perceval R., Carlton Terrace, Wynyard Square.
1884		Perdriau, Stephen E., "Claremont," Balmain.
1877		Perkins, Henry A., Burwood.
1881		Philip, Alexr., L.K. and Q.C.P., *Irel.*, L.R.C.S., *Irel.*, 540, Park View Terrace, Crown-street, Surry Hills.
1876		Pickburn, Thomas, M.D. *Aberdeen*, Ch. M., M.R.C.S. *Eng.*, 40, College-street.
1879		Pittman, Edwd. Fisher, L.S., Department of Mines, Sydney.
1881		Poate, Frederic, Government Surveyor, Summer Hill.
1879		Pockley, Thos. F. G., Commercial Bank, Singleton.
1878		Poolman, F., "Restdown," Hawksburn, Melbourne.
1882	P 1	Porter, Donald, Tamworth.
1878		Potts, F. H., "Hydebrae," Coventry Road, Homebush.

Elected.		
1876		Quaife, Fredk. Harrison, M.D., Mast. Surg. Univ. *Glas.*, "Hughenden," Queen-street, Woollahra.
1876		Quodling, W. H., "Couranga," Redmyre Road, Burwood.
1865	P 1	‡Ramsay, Edward, LL.D. (Univ. *St. And.*), F.L.S., Curator of the Australian Museum, College-street.
1876		‡Ratte, A. Felix, "Ingen. Arts et Manuf." Paris, "Officier d'Acad." Paris, Australian Museum, Sydney.
1874		Read, Reginald Bligh, M.R.C.S., *Eng.*, Coogee.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, 33, Castlereagh-street.
1881		Reid, William, Australian Joint Stock Bank, Sydney.
1881	P 2	Rennie, Edwd. H., M.A. *Syd.*, D.Sc. *Lond.*, Professor of Chemistry, University, *Adelaide.*
1870		Renwick, The Hon. Arthur, B.A. *Sydn.*, M.D. *Edin.*, F.R.C.S. *Edin.*, M.L.A., 295, Elizabeth-street.
1880		Riddell, C. E., Union Club.
1856		Roberts, J., 340, George-street.
1868	P 3	Roberts, Sir Alfred, M.R.C.S. *Eng.*, Hon. Mem. Zool. and Bot. Soc. *Vienna*, Bridge-street.
1881		Roberts, C. J., C.M.G., M.L.A., "Chatsworth," Potts's Point.
1871		Robertson, Thomas, solicitor, 85, Pitt-street.
1856	P 8	†Rolleston, Christopher, C.M.G., Palmer-street, St. Leonards East.
1885		Rolleston, John C., C.E., "Northcliff," Milson's Point.
1865		Ross, J. Grafton, O'Connell-street.
1884		Ross, Chisholm, M.B., C.M., Hospital for the Insane, Gladesville.
1885		Ross, Elsey Fairfax, M.D. *Brux.*, 145, Macquarie-street North.
1885		Roth, Reuter Emerich, M.R.C.S. *Eng.*, 42, College-street, Hyde Park.
1882		Rothe, W. H., Union Club.
1876		Rowling, Dr., Chas., Parramatta.
1864	P 32	†Russell, Henry C., B.A. *Syd.*, F.R.A.S., F.M.S., Hon. Mem. S. Aust. Inst., Government Astronomer, Sydney Observatory.
1875		Sahl, Charles L., German Consul, Consulate of the German Empire, Wynyard Square.
1876		Saliniere, Rev. E. M., Glebe.
1884		Sands, Robert, 374, George-street.
1876		Schuette, Rudolf, M.D., Univ. *Göttingen*, Lic. Soc. Apoth. *Lond.*, 10, College-street.
1883		Schulze, Oscar, 331, George-street.
1856	P 1	‡Scott, Rev. William, M.A. *Cantab.*, Hon. Mem. Roy. Soc. Vic., Kurrajong Heights.
1880		Scrivener, Charles Robert, Camp, Ryde.
1876		Sedgwick, Wm. Gillett, M.R.C.S., *Eng.*, Newtown.
1877		Selfe, Norman, C.E., M.I.C.E., "Rockleigh," Balmain.
1876		Sharp, James Burleigh, J.P., Clifton Wood, Yass.
1876		Sharp, Henry, Green Hills, Adelong.

Elected.		
1878	P 1	Sharp, Revd. W. Hey, M.A. *Oxon.*, Warden of St. Paul's College, University.
1883	P 1	Shellshear, Walter, Assoc. M. Inst. C.E., "Lauraville," Cambridge-street, Stanmore.
1879		Shepard, A. D., Box 728, G.P.O., Sydney.
1875		Sheppard, Rev. G., B.A., Berrima.
1882		Shewen, Alfred, M.B., M.D., Univ. *London*, M.R.C.S.E, Liverpool-street, Hyde Park.
1882		Sinclair, Eric, M.B., C.M., Univ. *Glasgow*, Lunacy Dept., Gladesville Hospital for the Insane.
1883		Sinclair, Sutherland, Secretary, Australian Museum.
1884		Skirving, Robt. Scot, M.B., C.M., Elizabeth-street, Hyde Park.
1877		Slattery, Thomas, M.L.A., Premier Terrace, 169, William-street, Woolloomooloo.
1877		Sloper, Fredk. Evans, 360, Liverpool-street.
1881		Smedley, John, 92, Eldon Chambers, Pitt-street.
1875		Smith, Robt., M.A. *Syd.*, solicitor, O'Connell-street.
1874		‡Smith, John M'Garvie, Assayer, &c., Denison-street, Woollahra.
1878		Smith, E. E., "Clytie," 70, Darlinghurst Road.
1883		Smith, Robt. Burdett, M.L.A., 203, Macquarie-street North.
1884		Smith, Fredc. Moore, M.D., M.R.C.S., Coast Hospital, Little Bay.
1879		Spry, James Monsell, Union Club.
1881		‡Starkey, John Thos., 61½, Castlereagh-street.
1882		Steel, John, L.R.C.P., L.R.C.S., *Edin.*, 149 Elizabeth-street, Hyde Park.
1872	P 1	Stephen, George Milner, B.A., F.G.S., Mem. Geol. Soc. of Germany; Cor. Mem. Nat. Hist. Soc., *Dresden*; F.R.G.S. of *Cornwall*; "Almaville," Pyrmont Bridge Road.
1879		‡Stephen, Septimus A., South Kingston.
1879		Stephen, Alfred F. H., Glebe Point Road.
1857		Stephens, William John, M.A. *Oxon.*, Professor of Natural History in the University of Sydney, 71, Darlinghurst Road.
1883		Stephen, Cecil B., M.A., 101, Elizabeth-street.
1884		Strange, Fredk. R., Burwood.
1878		Street, John Rendell, "Birtley," Elizabeth Bay Road.
1876		Strong, Wm. Edmund, M.D., *Aberdeen*, M.R.C.S., *Eng.*, Liverpool.
1874		Stuart, Sir Alexander, K.C.M.G., Sydney.
1876		Stuart, Clarendon, M.I.S., Cross-street, Double Bay.
1883		Stuart, T. P. Anderson, M.D., Univ. *Edin.*, Professor of Anatomy and Physiology in the University of Sydney.
1883		Styles, G. Mildinhall, Commercial Bank, George-street.
1884		Sunderland, Rev. J. P., 19, Wentworth Court, Elizabeth-street.
1876		Suttor, The Hon. Wm. Henry, M.L.C., "Cangoura," Bathurst.
1884		Syer, Frank Weston, 89, Pitt-street.
1879		Tarrant, Harman, M.R.C.S., M.L.A., Macquarie-street.
1862	P 10	Tebbutt, John, F.R.A.S., Observatory, Windsor.
1879		Thomson, Dugald, care of R. Harper & Co., 409, George-street.
1870	P 1	Thompson, H. A., Launceston, Tasmania.
1875		Thompson, Joseph, "Trahlee," Bellevue Hill, Double Bay.
1877		Thompson, Thos. James, 139, Pitt-street, Sydney.

lected.		
1885		Thompson, John Ashburton, M.D. *Brux.*, Health Department, Sydney.
1878		Thomas, F. J., Hunter River, N.S.N. Co., Sussex-street.
1882		Thornton, Hon. George, M.L.C., 377, George-street.
1876		Tibbits, Walter Hugh, M.R.C.S. *Eng.*, Manly.
1876		Toohey, J. T., "Moira," Burwood.
1884		Townsend, G. W,, C.E., Rooty Hill.
1882		Traill, Mark W., L.R.C.P. *Lond.*, M.R.C.S.E., Burwood.
1873	P 1	Trebeck, Prosper N., Hunter-street.
1879		Trebeck, P. C., Hunter-street.
1883		Trebeck, Tom B., M.A., *Syd.*, Univ., "Leyton" 72, Elizabeth Bay.
1885		Trickett, W. J., M.L.A., "Fairlight," Edgecliff Road, Woollahra.
1876		Trouton, F. H., A.S.N. Company's Offices, Sydney.
1877		‡Tucker, G. A., Ph. D., "Minnesota," Johnston-street, Annandale.
1868		Tucker, William, "Clifton," North Shore.
1875		Tulloh, W. H., "Airlee," Greenwich Point Road, North Shore.
1883		Tuxen, Peter Wilhelm, L.S., Survey Office, Sydney.
1882		Twynam, George Edwd., L.R.C.P. *Lond.*, M.R.C.S.E., "Cleone," West-street, Petersham.
1883		Vause, Arthur J., M.B., C.M., *Edin.*, Bay View House, Tempe.
1884		Verde, Felice, 16, Prione Spezia, Italy.
1885		Vernon, Walter N., M.S.A., "Clytha" House, Neutral Bay, St. Leonards.
1876		Voss, Houlton H., J.P., Goulburn.
1879		Walker, H. O., Australian General Assurance Co., 97, Pitt-street.
1867		Walker, Philip B., Telegraph Office, George-street.
1882		Want, Sydney A., "Carabena," Milson's Point, North Shore.
1867		Ward, R. D., M.R.C.S. *Eng.*, North Shore.
1883		Wardell, W. W., Fellow Royal Institute of British Architects, Lond., Member Institute Civil Engineers, Lond., "Upton Grange," St. Leonards.
1877		Warren, William Edward, M.D. and M.Ch., Queen's Univ. *Irel.*, 243, Elizabeth street, Sydney.
1883		Warren, W. H., C.E., Professor of Engineering, University of Sydney, "Madeley," London-street, Enmore.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, 121, Elizabeth-street.
1876		Waterhouse, J., M.A., *Syd.*, "Sauchie House," Church-street, West Maitland.
1876		Watson, C. Russell, M.R.C.S., *Eng.*, "Morevale," Newtown.
1877		Watt, Alfred Joseph, 523, George-street.
1859		Watt, Charles, Government Analyst, Treasury Buildings.
1876		Waugh, Isaac, M.B., M.C., *T.C.D.*, Parramatta.
1876		Webster, A. S., Gresham Chambers.

Elected.		
1867		Weigall, Albert Bythesea, B.A. *Oxon.*, M.A. *Syd.*, Head Master of the Sydney Grammar School, College-street.
1881		‡Wesley, W. H., Stella House, Penzance, Cornwall.
1878		Westgarth, G. C., solicitor, "Tresco," Elizabeth Bay.
1877		Weston, W. J., 5, Spring-street.
1879		‡Whitfeld, Lewis, B.A. *Sydney*, The Grammar School, Sydney.
1874		White, Rev. James S., M.A., LL.D., *Syd.*, "Gowrie," Singleton.
1875		White, Hon. James, M.L.C., "Cranbrook," Double Bay.
1877		‡White, Rev. W. Moore, A.M., LL.D., T.C.D.
1883		Whitelegge, Thomas, Australian Museum, College-street.
1884		Wiesener, T. F., 334, George-street.
1874	P 1	†Wilkinson, C. S., F.G.S., F.L.S., Government Geologist, Department of Mines.
1880		Wilkinson, Robt. Bliss, M.L.A., 12, Spring-street.
1878		Wilkinson, Rev. Samuel, Regent House, Regent-street, Petersham.
1883		†Wilkinson, W. Camac, M.D., M.R.C.P. *Lond.*, M.R.C.S.E., M.L.A., 229, Macquarie-street North, *Hon. Secretary*.
1876		Williams, Percy Edward, Treasury.
1884		Williamson, Willm. Collir, M.D., Hospital for the Insane, Parramatta.
1879		Wilshire, F. R., P.M., Berrima.
1878		Wilshire, James Thompson, J.P., "Havilah," Burwood.
1879		Wilson, F. A. A., Mercantile Bank, Sydney.
1876		Windeyer, W. C., M.A., *Syd.*, Puisne Judge, King-street.
1876		Wise, George Foster, Immigration Office, Hyde Park.
1878		Wise, Henry, Savings' Bank, Barrack-street.
1873		Wood, Harrie, Under Secretary for Mines, Department of Mines.
1884	P 1	Wood, Arthur Pepys, C.E., Sydney Club.
1879		Woodhouse, E. B., "Mount Gilead," Campbelltown.
1877		Woods, T. A. Tenison-, 110, Fitzroy-street, Moore Park.
1876		Woolrych, F. B. W., 11, Hill-street, Newtown.
1881		Wright, Frederic, M.P.S., Harnett-street
1872		†Wright, Horatio G. A., M.R.C.S., *Eng.*, Wynyard Square, *Vice-President*.
1878		Wright, Rev. Edwin H., St. Stephen's, Bourke.
1884		Yeomans, Allan, Gilgoin, *viâ* Byrock.
1879		Young, John, Young's Buildings, corner of Pitt & Park Streets.

Honorary Members.

Limited to Twenty.

M. recipients of the Clarke Medal.

1875		Agnew, Dr., Hon. Secretary, Royal Society of Tasmania, Hobart.
1884		Airy, Sir George Biddell, K.C.B., M.A., D.C.L., *Oxon.*, LL.D., *Cantab. et Edin.*, F.R.S., &c., The White House, Croom's Hill, Greenwich Park, S.E.

Elected		
1875		Bernays, Lewis A., F.L.S., F.R.G.S., Brisbane.
1876	P 1	Cockle, His Honor Sir James, late Chief Justice of Queensland, M.A., F.R.S., Ealing, London.
1876	M	De Köninck, Prof., M.D., Liège, Belgium.
1875		Ellery, Robert F., F.R.S., F.R.A.S., Government Astronomer of Victoria, Melbourne.
1875		Gregory, Augustus Charles, C.M.G., F.R.G.S., Geological Surveyor, Brisbane.
1875		Haast, Dr. Julius von, C.M.G., Ph. D., F.R.S., F.G.S., Professor of Geology, Canterbury College, and Director of the Canterbury Museum, Christchurch, New Zealand.
1875	P 1	Hector, James, C.M.G., M.D., F.R.S., Director of the Colonial Museum and Geological Survey of New Zealand, Wellington.
1880		Hooker, Sir Joseph Dalton, K.C.S.I., M.D., C.B., F.R.S., &c., Director of the Royal Gardens, Kew.
1879	M	Huxley, Professor, F.R.S., LL.D., F.G.S., F.Z.S., F.L.S., &c., &c., Professor of Natural History in the Royal School of Mines, South Kensington, London.
1875	M	M'Coy, Frederick, F.R.S., F.G.S., Hon. F.C.P.S., C.M.Z.S., Professor of Natural Science in the Melbourne University, Government Palæontologist, and Director of the National Museum, Melbourne.
1875	P 3 M	Mueller, Baron Ferdinand von, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S., Government Botanist, Melbourne.
1879	M	Owen, Professor Sir R., K.C.B., M.D., D.C.L., LL.D., F.L.S., F.G.S., V.P.Z.S., &c., &c., The British Museum, London, W.C.
1883		Pasteur, Louis, M.D , Paris.
1875		Schomburgh, Dr., Director of the Botanic Gardens, Adelaide, South Australia.
1884		Tyndall, John, D.C.L., *Oxon.*, LL.D., *Cantab.*, F.G.S., &c., Professor of Natural Philosophy in the Royal Institution, Albemarle-street, London.
1878		Walker, Thomas, Yaralla, Concord.
1875		Waterhouse, F. G., F.G.S., C.M.Z.S., Curator of the Museum, Adelaide, South Australia.
1875	P 14	Woods, Rev. Julian E. Tenison-, F.G.S., F.L.S., Hon. Mem. Roy. Soc., Victoria, Hon. Mem. Roy. Soc., Tasmania, Hon. Mem. Adelaide Phil. Soc., Hon. Mem. New Zealand Institute, Hon. Mem. Linnean Soc., N.S.W., &c., Union Club, Sydney.

Corresponding Members.

Limited to Twenty-five.

1810	P 1	Clarke, Hyde, V.P. Anthropological Institute, 32, St. George's Square, London, S.W.
1879	P 3	Etheridge, Robert, junr., F.G.S., &c., The British Museum.
1883	P 1	Feistmantel, Ottokar, M.D., Geological Survey, Calcutta.
1880	P 1	Miller, F. B., F.C.S., Melbourne Mint.
1880	P 1	Ward, Sir Edward, K.C.M.G., Major-General, R.E., Cannes, France.

OBITUARY, 1885.

Ordinary Members.

Elected.	
1870	Allen, Sir George Wigram.
1863	Fortescue, Dr. G.
1875	Helsham, Douglas.
1850	Morehead, R. A. A.
1876	Morgan, Dr. T. Cecil.
1882	Renwick, Dr. G. I., B.A.
1852	Smith, Hon. Professor, C.M.G., M.L.C.
1870	Wallis, William.
1881	West, Dr. A. A.

AWARDS OF THE CLARKE MEDAL.

Established in memory of

THE LATE REVD. W. B. CLARKE, M.A., F.R.S., F.G.S., &c.,

Vice-President from 1866 *to* 1878.

To be awarded from time to time for meritorious contributions to the Geology, Mineralogy, or Natural History of Australia, to men of science, whether resident in Australia or elsewhere.

1878. Professor Sir Richard Owen, K.C.B., F.R.S., Hampton Court.

1879. Mr. George Bentham, C.M.G., F.R.S., The Royal Gardens, Kew.

1880. Professor Huxley, F.R.S., The Royal School of Mines, London.

1881. Professor F. M'Coy, F.R.S., F.G.S., The University of Melbourne.

1882. Professor James Dwight Dana, LL.D., Yale College, New Haven, Conn., United States of America.

1883. Baron Ferdinand von Mueller, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S., Government Botanist, Melbourne.

1884. Dr. Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S., Director of the Geological Survey of Canada, Ottawa.

1885. Sir Joseph Dalton Hooker, K.C.S.I., C.M., M.D., D.C.L., LL.D., &c., Director of the Royal Gardens, Kew.

1886. Professor L. G. De Koninck, M.D., University of Liege, Belgium.

NOTICE.

Members are particularly requested to communicate any change of address to the Hon. Secretaries, for which purpose this slip is inserted.

Corrected Address.

Name ....

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Titles, &c. ....

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Address ....

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Date ....

To the

Hon. Secretaries,

The Royal Society of N.S.W.,

37, Elizabeth-st., Sydney.

ANNIVERSARY ADDRESS.

By H. C. Russell, B.A., F.R.A.S., &c., President.

[Delivered to the Royal Society of N. S. W., 6 May, 1885.]

Gentlemen,—

The Report of the Council places you in possession of all the particulars of the general progress and work of the Society during the past year, and there is but little that I have to add to what has been there said. During the year the following papers were read:—1884, May 7—President's Address, by the Hon. Prof. Smith, C.M.G., M.D., LL.D. June 4—"On the Removal of Bars from the entrances to our Rivers," by Walter Shellshear, Assoc. Mem. Inst. C.E. July 2—"Notes on Gold," by Dr. Leibius, M.A., F.C.S.; "Some Minerals new to New South Wales," by Professor Liversidge, F.R.S.; "On the Oven-mounds of Aborigines in Victoria," by Rev. Peter Macpherson, M.A. August 6—"Notes on the Trochoided Plane," by Lawrence Hargrave. September 3—"A new Form of Actinometer, by H. C. Russell, B.A., F.R.A.S. November 5—"Notes on some Mineral Localities in the Northern Districts of New South Wales," by D. A. Porter. December 3—"Notes on Doryanthus," by Charles Moore, F.L.S.; "Water Supply in the Interior of New South Wales," by W. E. Abbott; "Notes on a new Self-registering Anemometer," by H. C. Russell, B.A., F.R.A.S. December 17—"Embryology of the Marsupialia, Monotremata and Ceratodus," by W. H. Caldwell, M.A.

The Council regret that they have to record the loss by death of two honorary and seven ordinary members. The honorary members are—Sir F. P. Barlee, K.C.M.G., elected 1875; George Bentham, C.M.G., F.R.S., elected 1879. Ordinary members—Hon. John Frazer, M.L.C., elected 1875; V. W. Giblin, elected 1878, Dr.

L. H. J. Maclean, elected 1881; R. A. A. Morehead, elected 1850; H. Phillips, elected 1856; T. W. Shepherd, elected 1881; H. Arding Thomas, elected 1876.

George Bentham is a name which can never be forgotten so long as Australian botany is studied, and some short notes of his life will be interesting. He was born at Stoke, near Portsmouth, on September 22, 1800, and in 1805 his father, General Bentham, was sent to St. Petersburgh by the English Government, and there the family resided until 1807, during which time the future botanist acquired some knowledge of the Russian language. Returning to England with his family, General Bentham thought it best to educate his family by tutors, and hence George Bentham never went to any school. After some years the family removed to France, and had a large farm, where everything was done to improve the methods of cultivation, and for a number of years George Bentham had to give his undivided attention to the management of the farm; nevertheless it was here that he acquired a taste for the study of botany, which later on was to absorb all his attention. Taking up one day a book on botany, belonging to his mother, he was looking through it, and became very much interested in the methodical arrangement of plants, and was induced to try if, by the aid of the book, he could find out what the first plant he met with was. Succeeding in this after some difficulty, his interest was aroused, and he worked steadily on in his spare hours until he was induced to devote his life to the study of botany. In 1826 he was elected a Fellow of the Linnean Society, and ever after took an active part in it, and was made President in 1863, and resigned in 1877. By the publication of his first important work, on the "Labiatarum Genera et Species, 1832 to 1836," he made his mark in the scientific world. In 1854 he went to live in London, for the purpose of devoting himself to systematic work at Kew, and this work he continued until his death. Here he undertook the Flora of Hong Kong, which was the inauguration of the Colonial Floras which have from time to time been issued under the auspices of the authorities at Kew.

These finished, he began and completed the description of the plants of Australia,—perhaps the most extensive local exotic flora ever published.

The most important work of his life was carried out in conjunction with Sir Joseph Hooker, being a revision after examination of the known "Genera of Phanerogams." This work was begun in 1860, and not finished until 1883. The strain of this great work over, and his aim accomplished, his health seems to have failed, and after a few months of weakness he died, September 20, 1884.

Had I consulted my own inclination, and perhaps ease, I should in what follows have prepared a *résumé* of the science of the past twelve months; but when I came to consider such a course, I found that the harvest in Europe had been well gathered, and that here the President of another Society had not only harvested first all that was of interest in the Colony, but had gathered in even our own little contributions to the general stock of human knowledge; and in reading to you the list of papers read before our Society last year, I felt that I was but repeating what had already been published. I have therefore turned to some unpublished items of scientific news, in the hope that they may prove interesting to you. The telegraphic determination of the longitude of Australia was, so far as the observations are concerned, completed some time since; but there were several links in the chain incomplete when Mr. Todd published the first statement of results, and, since the values for these sections now accepted differ from those used by Mr. Todd, his statement was incorrect. It may seem strange to some of the members that there should be any question about what is determined accurately; but no determinations of longitude are absolute—they are only relatively accurate, and where the observations are few in number and disagree it is necessary to determine, or perhaps it is better to say "agree," which shall be accepted. For instance, the longitude of Singapore, one of the links in the chain, has been determined twice, and the values differ by 0·78s., and it was impossible to get a new determination. Now one of the two had been obtained by using the telegraph line

so far as it went, and then transporting chronometers the rest of the way, and no determination of personal equation was thought necessary. The second value was obtained since the telegraph line was completed, by good observers, good instruments, and every precaution, including a careful determination of personal equation. It was at first proposed to take a mean of these values, but ultimately the later value was taken. I merely mention this to show what the difficulties are like, and that there is some uncertainty even in telegraphic determinations of longitude. As the report on the determination has been agreed to ready for publication, I will not detain you about it now, except to say that the resulting longitude of Sydney is 10h. 4m. 49·55s., which is 1·26s. less than the value derived from my observations of the moon, which were affected by uncertainty in the moon's place and the possible personal equation in observing the moon between the observers at Greenwich and Sydney. Any error of this sort would be magnified about twenty-five times in the resulting longitude, and therefore the above difference would represent a difference caused in this way of 0·05s.

There is a very general impression, borne out by the evidence which geology has furnished, that at least the east coast, if not all Australia, is rising in relation to the mean level of the sea. The late Rev. W. B. Clarke, in a report to the Port Jackson Harbour Commission, said "that the coast has risen in former geological epochs, and that it has risen during the present epoch is capable of distinct proof." "Raised beaches of shells, which are not kitchen middens, may be seen about 25 feet above the sea, near Ryde on the Parramatta estuary, and at Mossman's Bay, in Port Jackson, at a height of 132 feet above high-water." Again—"Regarding the whole coast from Broken Bay to Botany Bay as mere peninsulated fragments, united only by low isthmuses, bare or covered with sand, as they actually are, one may still see that there must have been oscillations of level, and finally elevation." Speaking of other portions of the coast, Mr. Clarke says:—"At Adelaide, in 1855, the railway between the city and the port was being constructed, and Mr. Babbage has since shown that in four

years a difference of 4 inches of rise between the levels of those places has taken place." And again—"According to Mr. Ellery—the accomplished and accurate Williamstown observer, the self-registering tide-gauge at that place indicated a rise of the bottom of Hobson's Bay of 4 inches in twelve months, and a deposit of recent shells and imbedded bones of sheep and bullocks which had been thrown into the bay is now seen at a level above the reach of the tides." Again, quoting from a letter by the late Mr. John Kent, of Brisbane:—"A survey was made of a shelf of rocks in Brisbane River in 1842, by Captain Gilmore, Mr. Petrie, and myself; and in making a re-survey in 1858 Mr. Roberts found the relative depths were singularly correct, but that the general depth of water over the shelf of rock had decreased 18 inches in sixteen years since the first survey was made."

Sir Roderick J. Murchison, in the Proceedings of the Royal Geographical Society of London, vol. vii., page 42, quotes from a letter he had received from the late Mr. Kent, of Brisbane:—"I have lately drawn the attention of the Rev. W. B. Clarke to the fact that the eastern coast of New Holland is rising, at the rate of (say) 1 inch per annum, as ascertained by the height of rocks in the river Brisbane above tide-levels, through a period of twenty years; and he assures me that to the south the same result has been inferred, though the observations have not extended over so long a period. At what rate the rise is now going on there are no data to establish. Till a series of mean tidal levels are marked on the rocks of the harbour, and the alteration made as distinct as that in Hobson's Bay, any deduction as to the rate of rise must be conjectural and unreliable." I have but taken a few extracts from a great mass of evidence which Mr. Clarke brought forward in proof of the rapid elevation of the coast of Australia.

I was deeply interested in this report when it was published in 1866, and as soon as I had opportunity determined to make such observations with a self-registering tide-gauge as would determine the rate of rise (if any); and, in collecting information bearing upon this subject during the past thirteen years, I wrote to Mr. Ellery

and asked him for futher particulars of the rise going on in Victoria; and in reply he said that Mr. Clarke had in some way misunderstood his remarks, which had reference to the silting up of the harbour—not the elevation of the land; and he at the same time sent me a copy of his paper on "The Tidal Datum of Hobson's Bay," read before the Royal Society of Victoria, August 14, 1879. After giving the history of the tide-gauge, which was started in 1858, under the Harbour Department, and was not under his control until 1874, Mr. Ellery says:—"It is to be regretted that no precise references to mean tide-level in the earlier days can be found. Where measurements do exist in Hobson's Bay, they are lacking in accurate information as to the state of the tides, and I find nothing trustworthy upon which to base any statements as to change of sea level since surveys have been made. I think it desirable that permanent bench-marks on the natural faces of the rock *in situ* should be established around our bay, carefully connected by accurate levelling with one another and with the tide-gauge, for it is very doubtful if bench-marks on buildings can be assumed to afford a permanent datum."

The first self-registering tide-gauge in Sydney was erected on Fort Denison, by the late Mr. Smalley, in 1867. Unfortunately the design was so faulty that all the records of the heights of tides made by it are of no value, although the times of high and low water are correct. The reason for this fault in its records was that an ordinary hempen cord was used to connect the float and the pencil, and this gradually got longer by use, and also varied with the weather. Finding it impossible to remedy this fault satisfactorily, in view of the necessity for exact records of the heights of the tides, in 1872 I had a new gauge made, which, without losing the accuracy of the time record which the old one possessed, ensured the correct record of the height of the tides. This instrument is figured and described in the "Sydney Meteorological Volume for 1878," and to that work I must refer you for particulars. The record by the new gauge was begun on June 27, 1872, and at that time the precaution was taken of measuring the

length of the chain connecting the float and the wheel, so that should any change take place its exact amount could be ascertained. The wisdom of this has been evident on several occasions when the chain was broken by accident and the exact length restored. The well made for the tide-gauge is in part cut in the solid rock, and from the rock to the surface of the ground the sides of the well are built up (round) with solid masonry, so that the top ring of the well is practically part of the solid rock, and cannot move unless the rock does so. On this ring the frame of the tide-gauge stands, and the instrument, therefore, has a permanent relation to the rock, and there can be no change in its parts which might be mistaken for a change in sea-level.

I have been particular in detailing the conditions under which the tide measurements have been made, to show you that sufficient precautions to ensure accuracy have been taken. In each year the mean of all the tides is taken as the mean sea-level for that year, and when these results for the past twelve years are placed side by side, it is at first sight rather puzzling; for although the greatest departure from the mean of all is only 1 inch, yet within this small range the land seems to rise and fall in an erratic way. The cause of these variations, however, was found in the varying relative positions of sun, moon, and earth, and perhaps to some extent in the effects of heavy gales. Taken as a whole, these results seem to prove conclusively that no change whatever has taken place in the relations of land and sea during the past twelve years. Of course the question is not settled—a slow change that would be visible in centuries might be altogether hidden in the results before us; but so far as they go these results will be interesting to scientific men, for they are the first that have been taken with such accuracy as the investigation demands.

Mean sea-levels :—

1873...	...	...	...	2 feet	5·9 inches
1874...	...	...	...	2 „	7·0 „
1875...	...	...	...	2 „	6·3 „
1876...	...	...	...	2 „	5·5 „

1877...	... ...	2 feet 6·7 inches
1878...	... ...	2 „ 6·0 „
1879...	... ...	2 „ 5·5 „
1880...	... ...	2 „ 6·2 „
1881...	... ...	2 „ 5·2 „
1882...	... ...	2 „ 6·1 „
1883...	... ...	2 „ 6·8 „
1884...	... ...	{ 2 „ 6·95 „ 2 „ 6·18 „

In examining this question, I looked for some mark of old surveys which might show what the evidence of a longer period would be, but I have failed to find any mark put in with such care as the investigation demands. There is, however, one mark on the north-east face of the round tower on Fort Denison, which was put in by H.M.S. "Herald," during her survey of Sydney harbour. It is cut in the stone, 3 feet above mean sea-level, and is marked with the broad-arrow under it. I have been at some trouble to find out on what observations this mark was based; but although I have learned that the survey was made in 1857, and that the "Herald" was in port from February 26 to December 21, 1857, I cannot learn how long the tide observations were continued, but I hope still to do so. The time and method of taking mean sea-level might account for a difference from the true mean of 4 or 5 inches, as is shown by the different monthly means from the recording tide-gauge, and until I can learn on what observation the "Herald's" mark depends, it cannot be used as evidence of change of level of the land. I have, however, connected it carefully with the zero of the tide-gauge, and if it exactly represents mean sea-level in 1857, it proves that the land has risen 5 inches in twenty-seven years; but since the tide-gauge shows no change whatever during twelve of these years, there can I think be no doubt that the mark was put in upon insufficient data; perhaps only day-tides were observed.

In the course of conversation with the late Rev. W. B. Clarke on the question of the elevation of the coast, he

pointed out to me evidence not only of the elevation of this coast, but also of its subsidence, and expressed his conviction that Port Jackson, Hawkesbury River, and other places on the coast, had been cut out by the action of fresh water, when the coast was much higher than it is at present—in fact, that these inlets had been at one time gullies exactly similar in character to those which now exist in the Blue Mountains, and which have been so obviously cut out by fresh water. Since that time many bridges have been made along the coast, and the borings made for foundations for these bridges have special significance in connection with Mr. Clarke's opinion; and by the kindness of the Engineer-in-Chief for Railways and the Engineer-in-Chief for Roads and Bridges I am able to quote here some of these measures, which prove conclusively that the sea was at one time much lower than it is at present. The soundings taken for the Parramatta railway bridge show 26 feet water, 32 feet mud and silt, 8 feet loose sand, 12 feet hard sand, 10 feet loose sand; total, 88 feet. George's River bridge—8 feet water, 87 feet mud and sand, 9 feet black clay, 16 feet sand, 4 feet hard sand; total, 121 feet. Hawkesbury River bridge—44 feet water, 31 feet light mud, 87 feet black mud, 8 feet very hard sand; total, 170 feet. In the road bridge over the Parramatta River—41 feet water, 16 feet shells and mud, 15 feet sand, 9 feet blue clay, 6 feet clays and shells; total, 87 feet. Ironstone Cove road-bridge—26 feet water, 7 feet stiff blue clay, 36 feet very stiff blue clay, 15 feet yellow clay, 5 feet stiff black clay, 11 feet sand and clay, 2 feet clean sand, 3 feet gravel and wood; total 105 feet. Shoalhaven River road-bridge—14 feet water, 103 feet mud and silt; total, 117 feet. The bottom of the Hawkesbury, therefore, where the railway bridge is to be, is 170 feet below the level of the sea to-day; and when the rocks were washed away to form the river-bed to that depth the sea must have been at least 170 feet below its present level, and the borings in Sydney Harbour and George's River indicate a similar fact, if not to the same extent.

Without going further into this question, which is foreign to my present purpose, I think I have said enough to show that the

evidence for elevation and subsidence of the land are about equal, the question before us being in which direction is the change going on now. In estimating the value of the evidence quoted as to the rate of rise in Queensland and South Australia, we must not forget that when engineers adopt the usual rule as to mean sea-level—that is, as to the mean of high and low water at any time of the year—they assume that all such means are equal or represent a constant level, when in point of fact two such determinations of sea-level may differ by 8 inches or even more ; and, in the absence of a self-registering tide-gauge, or constant observations extending over a year, no levelling referred to the sea in the usual way is of any value whatever in such an investigation as that required to determine whether the relative level of land and water varies. I have already shown that Mr. Ellery thinks there is no evidence of present rising in Hobson's Bay; and the fact that at the time the engineering levels referred to were taken in South Australia and Queensland there were no self-registering tide-gauges to determine accurately mean sea-level, is sufficient to warrant us in hesitating before we receive the evidence as to the rate of elevation furnished from these Colonies which I quoted from Mr. Clarke's report. In fact, it seems that the only observations of the relative level of land and sea in Australia taken with the accuracy which the investigation demands are those made with the Sydney tide-gauge, during the past twelve years, and they show conclusively that during that period there has been no appreciable change, and therefore we cannot say that the east coast at Sydney is either rising or falling.

Every year now is adding some facts towards the better understanding of the laws which regulate our rainfall, and every now and then some departure from the common course of things appears like a finger-post to indicate what is going on. You may remember that in 1882 I described a rain-storm that passed over the northern part of this Colony, travelling about E.S.E., at the rate of 12 miles per hour. In 1883, the February rain-storm passed over Lerida Station, which is in Queensland 8° north

of Bourke, or in latitude 22°. The station is a large one, and the storm came on to the station from the north-east. It was 4 miles wide at entry and 6 miles wide leaving the station, thence it spread out towards South Australia, and watered a large tract of country. In January of this year another of these storms crossed this Colony from Milparinka to Jervis Bay, or from latitude 30° to 34°. There was no barometric disturbance at the time, yet the storm was very well marked; I mean that the central portions from which the heavy rain fell, and which was about 200 miles wide, could be traced right across country, that is, for 700 miles, travelling at the rate of 7 miles per hour. Along the southern side of its track the rain fell off abruptly, leaving a well-defined line between the wet and the dry country, but on the northern side, just like the 1882 storm, the rain shaded off gradually, watering a large tract of country.

Closely allied to these rain-storms, although in appearance so utterly different, are the great dust-storms which often pass over the western plains: generally more circumscribed, they nevertheless are of great extent, follow the same south-east course, and change their latitude with the peculiarities of the season. One of the best marked of which I have any particulars followed just the same track as the January rain-storm, right across the Colony, and all that I have been able to trace follow a nearly parallel course. At times the dust carried by these great storms is so thick and extensive that it blots out entirely the light of the sun and makes total darkness at mid-day, and often it renders the sun invisible and artificial light necessary indoors. Such a storm passed over Bourke on 12th December, 1883; the wind and dust were terrible for ten hours, and the oldest inhabitant had never seen anything like it before. This storm produced the remarkable dry fog noted in New England and Paterson Districts at that time, but in no account of it that I have received had the dust the intensity which marked a recent storm of the same character that passed over Narrandera on Feb. 6th. At Hay this storm appeared as a severe ordinary dust-storm; 40 miles east of Hay it made total darkness for a few seconds; 40 miles further east it was dark as the blackest

night for five minutes; and 40 miles still further east, on Buckingbong Station, it blotted out every trace of daylight for fifteen minutes, although it was nearly mid-day in the summer. At 2·15 p.m., three persons caught in the bush had to sit behind a stump for shelter and could not see their hands before them; at the same time they endured a sensation as if choking with dust; and when the thick of the storm was past, the sun was a crimson ball of fire, the strange light causing people to run out of their houses, thinking the world was on fire and the end of all things had come.

The storm is said to have reached Albury at 2·30 p.m.; a dense cloud suddenly rose in the west, and seemed to be on the town in a moment, and almost as suddenly there was total darkness which lasted twenty minutes, black as the blackest night without ray from moon or star. Everything moving had to stand still till it was over; even fowls were found, when the light returned, asleep on the ground. Near Narrandera, on Columbo Plain, the force of the wind was terrific, blowing down trees in all directions; one man caught in it could not sit on his horse and had to get off and hold the horse round the neck to keep himself from being blown away. At Buckingbong, Mr. Bryan Blair, who reported the storm to me, says that it had looked like a storm all the morning, but at 2 p.m. the appearance was appalling; the clouds seemed to be rolling up into and over one another in the wildest confusion, and every one feared that something dreadful was going to happen. The forward motion of this storm was much more rapid than the rain-storm, but its character is the same—an off-set from the trades, the one being a very large storm carrying rain, the other a violent wind vortex carrying clouds of dust. It travelled from Hay to Narrandera, 100 miles, in 1½ hour, and thence to Wagga Wagga, 50 miles, in an hour. As the rate of progress was 50 to 60 miles per hour, and it produced total darkness for a quarter of an hour, the dust cloud must have been about 15 miles wide in its densest part, and in the following dust cloud wider still. It is impossible to say how high it was; but a dense cumulous cloud never shuts out the light entirely, and they are sometimes fully 3 miles thick.

I may be excused for mentioning here a fact of much interest, but somewhat disconnected from the others which surround it. When in the Bourke district a few weeks since, I learned one fact which has a bearing upon the doctrine of the survival of the fittest. For part of 1884 and the first three weeks of 1885 the western districts suffered from a drought which left the plain country without a sign of grass—it was literally "as bare as any road." Between the 24th January and the end of the month abundant rains fell, and the grass grew very rapidly. I passed over some of these plains on the 16th March, say six weeks after the rain, and they were covered like wheat-fields with barley grass 18 to 24 inches high, and the seed had all been ripened and shed in that short time. Upon expressing my surprise I was told that it had been known to grow up and do the same in four weeks. As it is a common thing in that district for the rain to come in February or March, leaving only six or eight weeks before winter, it is obvious that the grass which would seed in the shortest time would be most likely to survive.

Some few months since, it occurred to me that it would be desirable to put a self-recording gauge on Lake George, with a view of keeping a continuous record of evaporation, and other changes of level in it; and as soon as the instrument could be got ready I put it up on the west side of the lake, in front of Douglas House, which is about a mile from the present southern end. The instrument is essentially the same as the tide-gauge referred to in the earlier part of this paper; but it differs in giving 4 inches of paper to the foot of water, and only 3 inches in the day for the time scale, instead of 24 inches as the tide-gauge. The float also is of glass instead of copper. To ensure the stability of the base of this instrument, six piles 6 inches in diameter were driven as far as possible into the lake, and then cut off 3 feet above the water; the tops were secured together by a strong frame covered with 2-inch planking, and then strong diagonal bracing was fixed between the posts, which makes them into one compact frame, quite strong enough to withstand any waves or wind known on the lake.

This stage is 6 feet square, and on the top of it a small iron house, 6 feet × 5 feet, was put up to cover the recording gauge. A hole was then cut through the floor, and the iron well for the float let down. This is 18 inches in diameter, and is bolted to the floor, and by cross-bracing to the posts below. In the bottom of it, six holes, an inch in diameter, were made; these allow the water to go in and out with sufficient freedom to show ordinary waves without knocking the float about. The house is built at the end of the jetty in front of Douglas House, and is 60 feet from the shore, the water at that distance from the edge being only 4 feet deep.

The work of erecting the instrument was completed on the afternoon of February 18th, and the pencil was put down on the paper to begin its curious record at 7 p.m. on that day. At the time the lake seemed calm as a millpond, and looking at its smooth surface no one would have dreamed that such changes were going on in it as began to reveal themselves so soon as the pencil touched the paper, and in two hours the pencil had recorded a rise and fall of about 2 inches. This is not a motion like the ordinary wind-made waves, which pass by in two or three seconds, but a slow and gradual rise, occupying an hour, and then a corresponding fall in about the same time, to do which a current must first have set from north to south for an hour, and then reversed; and if we consider for a moment the force necessary to put a body of water 18 miles long, 5 wide, and 15 or 20 feet deep, in such motion, we shall get some idea of the magnitude of the forces at work. The record had not been going twenty-four hours when it became obvious that these periodic motions in the level of the water had a period of about two hours; and on the afternoon of the second day a heavy thunder-storm passed over the south end of the lake, and threw a little light on the cause of the pulsations. The storm rain was very heavy, and much of it must have run into the lake, tending to raise the waters there. With the storm there came a violent squall of wind from the south, on to the south end of the lake; in a few

minutes great foam-crested waves could be seen in the middle, and the recording-gauge at once showed what was the matter; the wind had blown the water away from the south end and reduced the general level 3 inches. In ten minutes the squall was over, and the water began to recover its level, in doing which the current set towards the south end of the lake, and could be seen running past the jetty at the rate of about 2 miles per hour; but it did not stop when the old level was reached—the momentum carried it beyond that point, and raised the water up at the south end of the lake. Then it turned and ran back again, repeating this process time after time at intervals of about two hours, the rise and fall getting gradually less, until in about eight hours, the water was almost still, when suddenly, at 11·30 p.m., the water began to rise faster than ever, and in thirty minutes had risen 4 inches; it then turned and fell nearly as fast as it had risen, and reached its lowest point in one hour forty-one minutes, having fallen exactly 6 inches. At Douglas House the night was fine and calm, without the sign of a storm; yet it seems probable that a storm passed over the north end of the lake, and started the motion, which kept on at intervals of about two hours for fourteen hours, the rise and fall gradually getting less. I was fortunate enough to be present and see so much of the record and the corresponding weather. You have no doubt noticed that one set of pulsations was started by a sudden fall and the other by a sudden rise in the lake, and that the impulse which caused the water to rise was greater than the other. Similar impulses have kept the lake in almost constant motion ever since, and when once under way, they will go on throughout a gale of wind with just as much regularity as in a calm. Ordinarily such a set of motions lasts ten or twelve hours, decreasing gradually as if the friction of the water stopped it, but on several occasions they have kept on for days together.

The most remarkable impulse yet recorded was on the 14th of April, when the water was remarkably still, and had been so during the 11th, 12th, and 13th. At 11 a.m. on that day Mr.

Glover, who has charge of the gauge, saw a thunder-storm coming down from the north, and went into the recording-house to see its effect. The lake was rising fast, and in thirty minutes rose 4 inches. As the storm passed overhead the rising ceased, and the lake at once began to fall, getting back to its previous level in fifteen minutes; passing this point it fell 2 inches more—in all 6 inches—and then began to rise again, so starting a series of pulsations that lasted five days. Rain came with the storm, and on the 14th and 15th, measured by gauges at each end of the lake, 1·10 inch rain fell, and this caused a rise of 1½ inch in the lake, which can be distinctly seen in the record as something independent of the pulsations. With the rain there was a strong breeze of wind, and, by the third day after, the water had returned to its old level, all the rain having evaporated in three days. In each of the cases I have mentioned so far the impulses seem to have been given by a sudden storm breaking over the lake, but there are other instances in which the impulse was of a totally different character, and it seems as if a small force properly managed was made to do duty for a large one, just as we set a heavy weight suspended by a string in motion by giving it first a little push, and then adding impulse to each swing. So the force, whatever it be, which in these cases acts on the water in the lake, gives it a little start and gradually gets it in motion. The best instance of this occurred on the afternoon of April 5th. At the time the lake was very quiet, and suddenly the water rose an inch, and fell again within thirty minutes; next time it rose an inch and a half, and fell 2 inches in three-quarters of an hour; the next time it rose 2 inches, and fell 3½ inches in an hour; it then rose 3¾ inches in forty minutes, and so started a series of pulsations which settled down to two-hour intervals, and lasted twenty hours. Usually the rise and fall take about equal times, but now and then the whole fall will take place in fourteen or fifteen minutes and the corresponding rise take 116 minutes, and it is not very unusual to find one in a set of twice the period of the others, as if one had been left out; in fact the variations in the conditions of vibration are very puzzling. With a view of finding out the most common period, I have measured

fifty-four of the best defined amongst those already recorded. Of these, thirty-three have a period of two hours eleven minutes, five a period of two hours five minutes, six a period of two hours seventeen minutes, and ten a period of one hour twelve minutes. The periods of those on the Lake of Geneva are seventy-two minutes and thirty-five minutes. Of those in Lake George which have a period of two hours eleven minutes, some are the largest yet recorded, and others only half or a quarter of an inch rise and fall; so that there must be something which makes or tends to make the period two hours eleven minutes. It is noteworthy that at Lake George as well as the Lake of Geneva the short seich is not half the long one, but they bear about the same proportion one to the other in each case.

As to the cause of these motions in the lake I am not prepared to say much at present. Further investigation is needed, and I hope, by the aid of a recording aneroid already there and a recording anemometer to be erected shortly, to be able to compare the changes of wind and pressure with the changes in the lake; but I do not expect to find everything explained thus. Changes of level, &c., are going on in the earth-surface which, from an astronomical point of view, are intensely interesting, because they affect the instruments, and therefore the measures. They are very minute, and we have no means of keeping a continuous record of them; but it is possible that if such changes affect the lake, they will be so magnified by its comparatively enormous extent as to show themselves on the recording instruments there. The baragraph at Sydney has shown long since that thunder-storms come on with a sudden rise of the barometer, which at times amounts to a tenth of an inch. If such a change could affect one end of the lake for a few minutes it would be equivalent to putting suddenly on to it an inch of water, which would make itself known at once by a rush to the other end; but although such changes must have some effect, I do not think it can be considerable, because, as I have elsewhere shown, these storms move at the rate of about 60 miles per hour, and are often 70 miles wide, so that such a storm coming on to the lake would spread all over it too rapidly to cause much motion in the water.

I am here assuming that the storms there are of the same character as those which pass over Sydney, but they may be smaller when passing the lake, and travel more slowly. Certainly the storm which I saw coming down the lake did not travel with anything like such velocity. M. Vaucher, who studied for years motions of the same kind which take place in the Lake of Geneva, considered himself justified in saying—"The lake is disturbed when the barometer is unsteady; and because of the varying pressure." From what I have seen so far, the first part of this is true of Lake George, but it is not because the barometer is unsteady, but because at such times the wind is puffy and variable, and imparts to the water its own peculiarity. Of the power of the wind to set the water in motion I have mentioned several instances to-night, which I need not repeat, but I may add that the large impulses come from the north because, as it seems to me, the wind from that direction acting on the water the whole length of the lake has greater power than when blowing from the south over a mile of water. The gauge is fixed about a mile from the south end. But although the wind is such an obvious cause of the phenomena under discussion, I think the barometric changes have some share in it, and there are some changes recorded which, so far, I am unable to refer to any cause.

In the European lakes, in addition to the changes of level due to rain and evaporation, there are other changes of level independent of these causes, and which resemble tides in their rhythmic periods. These have long been known and observed in Switzerland, and especially on the Lake of Geneva, where they are known by the name of "seiches." When they affect the lake its level is observed to rise slowly during thirty or forty minutes to a height that varies from a few inches to as many feet; it then falls again slowly to a corresponding depth, and so on. These seiches have been studied for many years, and M. Vaucher said that he had observed that "when the barometer was at rest the seiches were small, are greater when the barometer is variable, and greatest when the pressure is falling." A seich is defined as a complete motion of

the water in rising and falling, and its "period" as the time it takes to complete the motion. Their amplitude is very variable, but at the same place and on the same day they are all alike: when large all are large, and when small all are small. Sometimes, as on August 3, 1763, they have been measured 4 feet 10 inches rise and fall; and on 2nd and 3rd October, 1841, some were measured 6 feet 7 inches. They are greater at the ends of the ake than in the middle, and the period varies very much with the size of the lake; but in the Lake of Geneva, which is 45 miles long and 8 wide, the longer ones have a period of seventy-two minutes, and the shorter ones of thirty-five minutes. Dr. Forel, who has studied those of the Lake of Geneva, very carefully attributes the ordinary seiches to local variations of atmospheric pressure, giving an impulse, the effect of which lasts a long time in the oscillations of the lake; but those of from 4 to 5 feet he attributed at one time to earthquake shocks, but now thinks they are due to violent gusts of wind, for at least one earthquake passed the lake without producing such motions. Mr. Plantamour, who was watching at the end of the lake, while Dr. Forel was in the middle, said, after long and careful study he was quite at a loss for an explanation of these curious motions.

Some of the surroundings of Lake George are of very great interest, viewed in the light of discussions as to the possible change in the amount of rainfall in the Colony during long periods; and although I cannot now stay to discuss them at length, I cannot pass them without a short reference to their bearing on the question. The lake itself is situated in a depression between two ranges of hills, some of which, on the western side, rise to 800 feet above the lake. On the eastern side the hills generally stand some little distance from the water, but on the western side, at least in a part of it, the hills seem to rise abruptly out of the water at an angle of from 30° to 45°. The hills are composed of hard metamorphic rocks, the fragments of which are carried down into the lake by every shower, and are very soon polished into gravel by the action of the waves; and the enormous deposits of gravel at

both ends of the lake, where the ground is flat, as well as along the sides, point to a duration of present conditions which is very hard to realize. At the present time there is a gravel ridge a short distance from the water at the south end. It is 1¼ mile long, has been tested for ballast for the railway, and found to be at least 15 feet thick where deepest, and has a base of about 100 yards. This is one of a number of such deposits at the south end of the lake. At the railway works, Bungendore (south end), a well was sunk for water about 1½ mile from the lake, in ground the surface of which would, I should think, be about 20 feet above the present level. There was 4 feet of earth on top; then clean gravel to 28 feet deep. There the abundance of water stopped the sinking; and 6 miles from the lake, though still on the flat land, which evidently is part of its ancient bed, a well was sunk, and near the top of it gravel was found, and carried down to 18 feet, where it contained so much water that they could not sink any deeper. At the north end of the lake these conditions are found in duplicate almost exactly, only there the gravel ridges seem to be higher. The most recent of these gravel deposits at both ends of the lake abut on to the western mountains, and extend thence obliquely across the old lake bed, thus cutting off from the main body portions of it which are now swamps. The southern one, however, does not hold water well, while the northern one has always been known as the wet lagoon, because it always contained water until last year, when Mr. Beit succeeded in draining it.

With reference to the height of these ridges above the water now, I was unable to take any levels at the northern end of the lake; but at the south end I ran the level from the 1871 flood level to the top of the gravel ridge 197 feet, the rise being 22 feet 8 inches; thence down the other side of the ridge to the bed of the swamp, descending 18 feet 8 inches in 93 feet; the old swamp bed is therefore only 4 feet above the 1871 level of the lake. I then took in eight places the difference in level between the present water and the 1871 level, and found the mean to be 11 feet 11 inches on February 20 this year. The extremes of these

measures differed 4 inches. Some were taken to the edge of the 1871 gravel as nearly as it could be determined, and others to the high-water-mark on the old dead trees. During the day the register shows a variation of level in the water of 2 inches, which, as it was rising and falling, was probably eliminated in the mean. If, therefore, we add together the differences between the present water level and that of 1871, between that and the top of the gravel ridge, we find it is 34½ feet, and at one time the lake must have been as high or nearly as high as that in order to pile up the gravel. At first it is difficult to see any reason for the formation of the gravel deposit where it is; but looking at the 1871 level, one sees the nucleus of another in a thin line of gravel about 1 foot thick. Such a deposit on flat ground would grow, if the level of the water was at all constant, and gradually a ridge would be formed. The direction of these ridges at right angles to N.E. and S.E. winds points to a probable past when the winds were alternately from these directions during long periods; and as the gravel is made at the western edge of the lake and not at the ends, it must have been transported along the margin and thence out on to the flat country by the action of the waves.

In the absence of levels it is impossible to say what was the extreme size of the lake in its wet period, but, I should think, at least 40 miles long and 10 or 12 wide. The steep hills which bound the lake on the west side are deeply furrowed by water, and afford striking evidence of a time when rain must have fallen in vastly greater abundance than it does at the present day. Each of these gullies when examined is found to have a more or less extensive delta, which has spread out laterally and into the lake, forming there a projecting point opposite the gully. These are now covered with trees, and add very much to the beauty of the lake by their picturesque effect. In many cases, especially at the south end of the lake—that is, near Douglas House—these deltas are cut through by the watercourse which serves to carry off the rains of the present day; and these reveal distinctly the character of the deposit through which they run, showing that it

is made up entirely of loose stones scarcely rounded at all, lying now just as they were washed off the hills and down the gully thousands of years since. I will not attempt to say how many thousands; but when we find from the evidence of the lake dwellings in Europe how little change has taken place in the level of the European lakes during the historic period, the change which is manifest in Lake George points to a very remote period. Herodotus, B.C. 500, speaks of the lake dwellings; and the modern antiquary assigns to those of Switzerland a date 1500 B.C. Yet so little has the level of the Lake of Zurich changed in that time that the dry winter of 1853–54, by lowering the water in the lake one foot below previous levels, revealed to Dr. F. Kellor the artificial arrangement of some of the pieces of wood laid bare by the receding water, and thus led to his remarkable discoveries. This persistence of level is very strong evidence in favour of the view that there has been no great change in the rainfall there for thousands of years, and probably the same may be said of Australia.

But to return. Some of these watercourses are 10 to 12 feet deep, and the gravel that is moved in them by rain now is very small indeed compared with some of the stones which appear embedded in the delta they have cut through. One of the largest of these deposits is at Douglas House, and as you stand on the side of the hill you can see its rounded form starting at something like 50 feet above the level of the lake. It spreads out some 400 yards to the lake, and about as much laterally. It is now covered with large trees 2 to 3 feet thick, but its form shows clearly that it is a deposit from the gully above, which extends only half-a mile, and does not seem to drain more than a square mile of the hills. All about the surface of the delta, as well as in the section referred to above, are indications of the loose and stony character of the deposit, while the gully, cut as it has been out of hard metamorphic rocks, bears witness to the tremendous power of water. In January this year 7 inches of rain fell here in two days, yet the water scarcely ran at all through the delta, what did come down finding its way to the lake by soaking through the

gravel; in fact, the heaviest rain now only makes a little stream 3 or 4 feet wide and a few inches deep. The greater level of the lake in that long past period is not difficult to understand when looking at the evidence of tropical rains which the gullies afford. At the same time, the obvious insignificance of the present rainfall as compared with that which formed the deltas and filled up the lake, and the enormous duration of the present order and condition of things, as proved by the discoveries in the European lakes, show how groundless were the fears gravely expressed in 1871 that the lake would rise up and cover Bungendore and Collector. The rainfall on the lake in 1870 was 50 inches, double the average rainfall, which is 25 inches, and it is not to be wondered at that the lake rose at an unusual rate. Still this rain, heavy as it was, only served to cut little gutters in the older deposits which had been brought down the gullies.

The primary object in placing the recording gauge on Lake George was to ascertain the rate of evaporation from such a large body of water, the conditions at the lake being very favourable for such an investigation. The record began on February 18, and the time since is too short to justify any assumption of the rate of evaporation there; but I may mention some of the facts that have been recorded bearing upon this question. In sixty-eight days the level of the lake has fallen 7 inches by evaporation; in this interval, according to the records of rain-gauges at each end of the lake, 3·55 inches of rain has fallen; so that ignoring the water which may have run from the hills during these rains, the lake has lost all the rain falling into it and 7 inches more, that is 10½ inches. During the past fourteen years the lake has lost by evaporation 12 feet; and in May, 1878, the railway survey carried down the western side showed that the lake was then 6 feet below its 1871 level, or 2,225 feet above the sea. It appears therefore, that in seven years, 1871 to 1878, the lake lost 6 feet, and again, from May, 1878, to February, 1885, say seven years, the lake again lost 6 feet by evaporation, and this of course in addition to all the rain which fell during that period. Taking the records

at Goulburn and Gungahleen, near the lake, the average rainfall for the first seven years was 27·95 inches, and during the next seven years 23·68 inches. One would expect to find more evaporation during the drier years, but this is not borne out by observations. From the rainfall and recorded evaporation the lake, therefore, lost by evaporation at least 3 feet per annum. I say at least, because some rain-water must have run into the lake in addition to that which fell into it directly, but its amount cannot be determined. In the heavy rains, January 24-5-6, 1885, Lake George rose, by measures taken at the jetty, 11½ inches, and there had been 6½ inches rainfall at Bungendore, 9½ inches at Collector end, and 8 inches at Gundaroo, say 8 inches over basin of Lake George. In 1870 about 50 inches rain fell, and the lake rose 14 feet—168 inches, *i.e.*, about 3 to 1, and in a recent case it was only 1½ to 1, yet this rain fell in about forty hours. In future the recording gauge will determine this, and perhaps then we may apply the experience gained to estimating how much ran in during the past fourteen years. That the gauge will serve this purpose is proved by what it has already done. On March the 11th a strong northerly wind came on, and in three days the lake lost by evaporation 1½ inch. On April 14 and 15 1·10 inch rain fell, with a strong wind, and by the 17th the lake had lost all the rain by evaporation, and was at the same level as on the 13th. On the other hand, in calm or almost calm weather, three, and even four days pass without any visible loss by evaporation. It should be stated, with regard to the rain on 14th and 15th April, that though 1·70 inch fell at Douglas, only 0·77 inch fell at the north end of the lake, and the rise in the water due to it was 1½ inch, so that it would appear but little of that rain-water came down the hills into the lake. The evaporation on the lake on a windy day shows to what extent the wind affects it. No doubt its effect on a large body of water is much greater than on a small one, because on the lake in calm weather the lower air must get to a certain extent saturated with moisture, and there being no wind to carry it away, evaporation practically ceases; but where small quantities of water are placed

to test evaporation, there is abundant means for th evaporated water to get away in the surrounding air which is not saturated. Evidence is accumulating that the evaporation from large tanks is not so great as has been supposed. The heat is, no doubt, very great in the inland plains, but the total absence of wind in the interior for considerable periods is obviously, from what has been shown to-night, an important condition for the saving of water.

At Bourke, recently, I was very much struck with the absence of wind, especially on the surface of the ground, and the self-registering anemometer which I erected there in March last bears important and measurable testimony on this point. The recording parts are so easily moved that they work satisfactorily with a velocity of 1 mile per hour. Taking the total number of miles of wind recorded at Bourke by an anemometer placed 25 feet above the ground during thirty days, I find it is 2,350 miles, or about 78 miles a day only. The strongest wind in that period shows 50 miles of wind in five and a half hours, and the smallest record for a day is 25 miles—little more than a mile per hour. In Sydney during the same period 7,050 of wind miles were recorded, and it is not uncommon to record in Sydney in three days as much wind as was recorded at Bourke in thirty days.

Lake George is called a fresh-water lake, and some have even gone so far as to propose to use it as a reservoir for the supply of towns. When there I ascertained that no one could use the water on account of its purgative properties, one glassful being quite enough to satisfy those who made use of it; and it is there said that the water running into the lake from the Currawang copper mine had poisoned all the fish. This is not literally true, for there are still fish in the lake; but very many were killed some years since, presumably by the cause mentioned. I obtained some of the water, and am indebted to Mr. Dixon, of the Technical College Laboratory, for the following interesting information as to what the water contains:—It is quite evident that with 187·5 grains of mineral matter per gallon the water cannot be used for domestic purposes; and from the fact that this matter is constan

being added to, it cannot improve, unless it were possible to withdraw large quantities of the water, and supply its place with rain-water; but during by far the greater number of years during which the lake has been known, viz., sixty-four years, the supply of rain-water going into it annually has not been equal to the evaporation, and there is no other outlet. After the great flood of 1870 the lake, during the last fourteen years, has gradually decreased by nearly a foot per annum, and similar conditions existed before; and it is therefore obvious that it would not be possible to wash out the salts with rain-water and artificial drainage except in wet years—perhaps once in twenty years.

Extract Mining Department's report, 1880:—"Three samples of water from the Currawang Copper Mines were sent for analysis, with special reference to their poisonous action on the fish in Lake George, and were therefore only examined with regard to the metals in solution. The metals were present as sulphates, and are stated below:—Water from the creek contains: Sulphate of copper, 1·12 grains per gallon; sulphate of zinc, 16·78 grains per gallon; sulphate of iron, 0·43 grains per gallon. Water from the working shaft: Sulphate of copper, 17·67 grains per gallon; sulphate of zinc, 53·54 grains per gallon; sulphate of iron, 1·42 grains per gallon. Water from the old shaft: Sulphate of copper, 6·42 grains per gallon; sulphate of zinc, 7·20 grains per gallon; sulphate of iron, 0·98 grains per gallon." This water would necessarily be poisonous to fish, and flowing into a lake without outlet, would ultimately render the whole water poisonous.

Technical College Laboratory, Sydney, 2 May, 1885.

My dear Mr. Russell,

The water from Lake George contains 187·5 grains per gallon of solid matter dried at 212° F. The residue has a strongly alkaline reaction, effervesces with acid, blackens much on ignition, but does not show the presence of nitrates in doing so. The metals present are aluminium, calcium, and magnesium; the acids, chlorine, carbonic acid, sulphuric acid, and phosphoric acid, the last two in small quantity. The salts are probably arranged as chloride of sodium, sulphate of sodium, phosphate of sodium, carbonate of sodium, and carbonates of calcium and magnesium. The purgative properties of the water are probably due to the salts as a whole, and especially the carbonate of magnesia. It should be borne in mind, however, that waters containing much organic matter frequently have a purgative effect.

W. A. Dixon.

P.S.—Zinc and copper are entirely absent.

Some, if not all, the dead timber now standing along the shore of the lake was killed by the great flood of 1871. The opinion of the present residents is that all the trees were killed then, but Sir Thomas Mitchell, in his account of a visit to the lake in 1828, says—"It was a sheet of water 17 miles in length and 7 in breadth. The water is slightly brackish, but quite fit for use, and the lake was surrounded by dead trees, measuring about 2 feet in diameter, which also extended into it until wholly covered by the water. An old native told us she remembered when the whole was a forest,—a statement supported by the dead trees in its bed." And Mr. John King, who from 1834 to 1841 resided at the lake, says that " in 1840 dead trees were still standing at the margin of the lake"; and it seems probable that some of the dead trees seen by Sir Thomas Mitchell are still standing, although the gum which grows there appears to rot away rapidly. I saw one tree, 4 feet in diameter, just inside the 1871 line, partly dead, but evidently depending for its little remaining life on some surface roots that ran uphill. With reference to the age of these dead trees, I may mention that a number of young gum-trees have come up within the 1871 line, and are evidently growing very fast. The largest of four, standing near the jetty, measures 23 inches round 3 feet from the ground, and is something like 25 feet high, or about half the height of the older trees near it. I could not ascertain how soon it appeared after the 1871 flood, but the opinion of persons living there is that it is not more than eight years old; and from the fact that it is some 4 or 5 feet nearer the lake than the 1871 line, it must, I think, have been at least three or four years after that flood before it began to grow.

In reviewing the results of such investigations as I have brought before you this evening, one is impressed by the slowness of the changes going on around us, and the immense periods over which they extend, compared with which the span of human life sinks into insignificance. To the scientific worker it seems to say, "You must be patient in investigation, accurate in measurement, cautious in accepting results, content to stand one in a long series who, for the good of humanity, are striving to interpret the laws of Nature."

A System of Accurate Measurement by means of long Steel Ribands.

By G. H. Knibbs, L.S.

[*Read before the Royal Society of N.S.W., 3 June, 1885.*]

When measuring in precipitous, or even undulating country, great difficulty has hitherto been experienced by surveyors, in obtaining, with any degree of accuracy, the horizontal values of the distances between any given points.

In the "Surveyor's Pocket-book," published by the Surveyor-General of the Colony, Mr. Surveyor Sheaffe, in an article on "Hypotenusal Measurement," bearing the date August, 1878, recommended the use of long steel ribands in rugged country in lieu of the one-chain tapes, then generally used. The results by the method suggested were incomparably better than those given by previous methods.

This system of measurement, when properly developed, is capable of yielding results scarcely inferior to the most careful trigonometrical surveys, and with comparatively little expenditure of time. The precision attained by its means in all classes of country is such as surpassed the most sanguine expectations of surveyors eight or ten years ago.

The novelty of the method is attested by the fact of its recent origination in this Colony, the credit of which belongs, I believe, to Mr. Sheaffe, of its still more recent theoretical development and subsequent practical testing by the writer, and by its absence from the standard works on surveying.

The accurate system of hypotenusal measurement may thus be briefly described :—

The distance between two given points is indicated upon a steel riband stretched between them, at a tension such that the result given is, in all cases, the same as that given when the riband is resting throughout its length, upon a smooth plane surface at a tension which makes it equal to an absolute standard at some given temperature. To this indicated distance corrections are applied for the variation from standard temperature and inclination with the horizon.

In practice, when the country to be surveyed approximates to a plane surface, the riband may lie wholly upon it; the angle of its inclination with the horizon being ascertained by observing a

point above the distant end equal in height to the height of the axis of the theodolite-telescope above the near end, which should be underneath it. When, on the other hand, it is undulating or precipitous, necessitating the suspension of the riband, it is obviously more convenient to hold one end to the axis of the telescope. The effect on the length of the riband arising from this suspension is eliminated by an increase of tension.

The ribands are of steel, of uniform area in their transverse sections, and are to be had, I believe, in sizes from ·045 inch wide and ·015 thick upwards, and weighing from about ·2 ℔ per chain, to about 1·5 ℔ per chain. Riband weighing ·3 ℔ per chain, about ·075 inch wide, in a 5-chain length, marked at every tenth link, has been found very convenient and satisfactory.

These ribands are elastic, and if stretched by the application of any moderate tension, return upon its removal to their original lengths. A tension sufficient to cause a permanent change in length is never required in practice, hence frequent comparisons with a standard are unnecessary.

By experiment it has been found that, through a very great range of tension, the *change* in length varies as the product of the tension and the length of the riband. The change in different ribands, of the same length and material, varies inversely as the areas of their transverse sections, or what is equivalent, as their weights.

This change in a soft steel riband, one chain of which weighs one pound avoirdupois, is ·00000779 chain for each pound of tension, and for each chain in its length. (*Vide* Appendix I.)

The weight of the riband should form the basis of computations, in preference to the area of the transverse section; it being impossible to measure the latter with any degree of precision.

The variations in length arising from the application of any tension may be found by means of the following formula :—

l, L = Original and stretched lengths (unit 1 chain).

w = Weight of unit of riband (unit 1 lb.)

t = tension applied.

k = ·00000779 chain.

$$L = l\left(1+\frac{tk}{w}\right), \text{ or } L-l = l\left(\frac{tk}{w}\right).$$

The elasticity of steel riband is constant or nearly so, at ordinary temperatures. Its value has been given for 60° Fahrenheit, and may be accepted for all temperatures occurring in the practice of surveying, without involving appreciable error. It is probable, however, that the elasticity increases with the temperature. It varies also in different kinds of steel, but only slightly. At a dull red heat a riband will be permanently lengthened by the application of even a moderate tension.

It is owing to this elastic property of the ribands that the reduction in the length between their ends, arising from their suspension, may be eliminated by increase of tension; the increase diminishing the ordinates, and at the same time lengthening the chords of the curves in which they hang. In other words, the tensions applied to the suspended ribands may be so increased that the chords of the lengthened ribands will equal their normal lengths; that is, their lengths at standard tension. A fuller consideration of this part of the subject will appear in the Appendices.

In order to avoid errors arising from slight bends or curves in the ribands, it is necessary to apply a considerable tension to them, even when using them upon a plane surface, or when testing at a standard. This tension will hereafter be called the *standard tension*.

The suspended riband hangs in a curve, which, unless acted upon by wind, lies wholly in a vertical plane. This curve is approximately the common catenary, and from its equations the formulæ hereunder may be derived.

When the ends of the suspended riband are in the same horizontal plane, and,

h = tension at the lowest point in curved riband,

t = the standard tension,

w = Weight of 1 chain of riband,

$$h^3 - th^2 - \frac{l^2 w^3}{24k} = 0.$$

From this equation h may be readily found with the aid of a table of squares and cubes, and h will be the tension to apply at either end of the riband; for conditions of accuracy render it imperative that t should be large compared with w; and when this is the case, the tension at the lowest point in the curve does not appreciably differ from the tangential tension at the end. The proportion $\frac{t}{w}$ = 30 to 35 has been found suitable to the necessities of practice.

When the ends of the riband are not in the same horizontal plane, and ζ = the angle between the chord of the riband and the zenith.

T' = the tension to be applied to the upper end.

T = the tension to be applied at the lower end and $\tau = \frac{T' + T}{2}$

$$\tau^3 - t\tau^2 - \frac{l^2 w^3 \sin^2 \zeta}{24\ k} = 0.$$

$$T' = \tau + \frac{lw \cos \zeta}{2}$$

$$T = \tau - \frac{lw \cos \zeta}{2}$$

When the values for h have been computed for the various lengths of the riband used, T' and T may be found very approximately by the equations

$$T' = t + (h-t)\sin\zeta + \frac{lw\cos\zeta}{2}$$

$$T = t + (h-t)\sin\zeta - \frac{lw\cos\zeta}{2}$$

These equations, though empirical, are very accurate for values of ζ between 60° and 90°; and as these angles most frequently occur in practice, will be found as a rule sufficiently accurate.

By means of the foregoing formulæ, surveyors are enabled to construct for the ribands used by them tables of tensions for use in the field.

When the tension applied to the riband is large compared with its weight, the curve in which it hangs has a small ordinate; and consequently a slight error in the amount of the tensions does not materially affect the difference in the length between the curve and its chord. Owing to the difficulty, however, of holding the ends of the riband at any desired points when it is under great tension, there is a practical limit to the amount that may be applied. This limit is between 20 and 25 lb. for men of ordinary strength.

For obvious reasons, there is a limit also to the length of riband that may be used. This may be said to be about 5 chains in rough and undulating country, and about 10 chains in level country.

A 5-chain riband weighing 1·5 lb., if standard length, at a tension of 10 lb., requires a tension of 19·5 lb. when the whole length is suspended; it is therefore eminently adapted for use in precipitous country,—a fact which has been verified by considerable experience.

If it be preferred to use a constant tension, and to apply corrections for the defects in length arising from the suspension of various lengths of riband, these may be found by means of the following formulæ:—

If r = correction

t = constant tension

ζ = angle between the chord of riband and the zenith

$r = \dfrac{l^2w^2}{24\,t^2}$ when $\zeta = 90°$

and when ζ differs from 90°

$r = \dfrac{l^2w^2\sin^2\zeta}{24\left(t + \dfrac{lw\cos\zeta}{2}\right)^2}$ if the tension be applied to the lower end of the riband, or

$r = \dfrac{l^2w^2\sin^2\zeta}{24\left(t - \dfrac{lw\cos\zeta}{2}\right)}$ if the tension be applied to the upper end

If r' represent the corrections reduced to their horizontal value the last two equations are converted into $r' = \dfrac{l^3 w^2 \sin^3 \zeta}{24\left(t \pm \dfrac{lw \cos \zeta}{2}\right)^2}$

The only instrument at present available for applying the tension is the spring balance. With a view to the attainment of accuracy the balance should be tested, and when in use the freedom of the bar attached to the spring must be ensured. If it touch the sides of the slot through which it passes the registered tension will be erroneous.

The effect of increase of temperature upon a spring balance is the diminution of the absolute amount of the registered tension. This is due to the elongation of the spiral spring and to the increase of its flexibility, by the heat. The difference is approximately proportional to the product of the tension and the temperature, and may be taken as —·000135 lb. for each degree Fahrenheit and pound avoirdupois. This was determined experimentally, with a good balance indicating 0 to 25 lb., through a range of 150° Fahrenheit. A difference of 50° temperature and 20 lb. tension would cause a variation of ·135 lb. tension, which in a 5-chain riband of the weight previously recommended would represent less than ·002 link. And as the effect of increase of elasticity in the riband, arising from increase of heat, nearly compensates this slight defect, it may be wholly ignored in practice.

As very considerable variations of temperature occur in daily practice, a correction must be applied for such variations if the ultimatum of accuracy be desired. This correction may be applied quite independently of that for "sag," or curvature of the suspended riband. Lavoisier and Laplace give ·00108 as the expansion of a unit of untempered steel for a change in temperature from 32° to 212° Fahrenheit. In a table of expansions for thirteen kinds of steel this is the least, and there is a very considerable range in the amounts. Hence, for measurements of the most refined description, the coefficient of expansion for each riband must be determined. In ordinary practice no error of any consequence will be introduced if 1·00115 be accepted as the coefficient for the range of temperature before mentioned. From this may be deduced the following simple but very accurate formula :—

If $2d$ = the variation in temperature (unit 1° Fahr.)

l = length of riband

R = correction in hundredths of links

$$R = \frac{dl}{8}$$

and for a difference of 60° Fahrenheit, and a length of 10 chains, this formula is in error less than ·01 link.

The ascertainment of the temperature of the riband in the field is no easy matter, and even its approximate determination requires considerable experience.

The precision with which the theodolite observation of the altitude of the chord of the riband must be observed will depend upon the requirements of the case. These will be limited by the rapidity with which the cosine of the angle changes, and by the accuracy of the instrument available. A properly-fitted 5″ theodolite may be depended upon to give angles within 15″ of their absolute value.

Some general remarks in regard to the details of this system of measurement will not here be out of place.

The friction of a light riband, when under a moderate tension upon ordinary ground may, in general practice, be neglected without appreciable error. When the surface is slightly uneven and the riband lying in a succession of little curves, a small increase of tension, the amount of which may be determined by a few simple experiments, will sufficiently correct the consequent defect.

Chaining upon the ground is most convenient when it closely approximates a plane surface.

The terminal marks upon the riband should be two or three inches short of the ends, so as to permit their easy and accurate adjustment to any given points.

The spring balance should be as close as possible to one of these marks, or may be so attached that its index-point will define the end of the chain. The latter method has the advantage of indicating the register of the tension, and the point to mark at together, so that they may be observed simultaneously.

Steel ribands marked at hundredth links are now obtainable, and by means of them the fractions of the chain may be recorded to almost any assigned practical degree of accuracy.

For facility in subsequent computation, whole chains should be laid out when possible.

The record in the Field-book may be conveniently made thus:—

500·00 links	D 20° 12′ 15″	F 72/30 = 469·357
22·105	E 1° 30′	F 74/30 = 22·103

D signifies depression, E elevation, F Fahrenheit, the subscribed 30 the temperature of the riband when at standard length.

In conclusion, it may be observed that the time occupied by the adoption of the system in practice is inconsiderable. If the strict application of the corrections be relaxed, it is by far the most rapid mode of measurement yet adopted, and under all circumstances gives results surpassing in accuracy any of the methods preceding it.

In the Appendices will be found a mathematical discussion of the whole problem, and also tables for computing the tensions for any riband with a considerable variation of standard tension.

Note.—I desire to express my indebtedness to Mr. F. B. W. Woolrych, District Surveyor, and to H. S. Hawkins, M.A., of the Trigonometrical Department, for various suggestions and help during my investigation of this subject.

APPENDICES.

I.—*Determination of Constant* ·00000779 *Chain.*

Three steel ribands, each 5 chains long, and each in one piece, weighing 1·40625 lb., 1·25 lb., and ·984375 lb., tested through a range of 15 lb., viz., from 10 to 25, gave as the extension in 1 chain, produced by a tension of 1 lb., ·02200 inch, ·02480 inch, and ·03106 inch respectively.

Multiplying these quantities by the weight of 1 chain of each riband gives the values ·00618750, ·00620000, and ·00611625 inch. The mean ·00616792, reduced to a decimal of a chain, is ·00000779, and this quantity will represent the extension produced by a tension of 1 lb. in 1 chain of riband weighing 1 lb. It will be very approximately true for the light steel ribands now in use.

The area of the transverse section of the riband, which is directly proportional to its weight, is that upon which the tension is distributed, and the effect of the latter therefore manifestly decreases in the same ratio as the area increases.

The mode of arriving at the equation $L = l\left(1 + \frac{tk}{w}\right)$ is too obvious to need illustration.

II.—*Correction for Curved Form of the Suspended Riband. The Catenary Curve.*

If the riband were *perfectly* flexible, the curve in which it would hang would be *very nearly* the common catenary (its elasticity causing the variation from the exact form of that curve). As, however, the method of using the riband involves the application of a great horizontal tension, as compared with its weight, the curve, although the riband is *not* perfectly flexible, will yet so closely approach the ordinary catenary that even the exact method of solution, viz., that which takes into account both the elasticity and the force requisite to bend the riband, will not give results appreciably differing from those given by the equations to that curve. Nor indeed will the results given by treating the curve as an hyperbola, a parabola, or as an arc of a circle, differ practically from the exact method.

Notation.

L = length of curve, unit 1 chain.
l = length of chord.
s = length of curve from point $x = o$, $y = c$.
h = horizontal tension, unit 1 lb.
$c = \frac{h}{w}$ = length of riband equal in weight to h.
ϵ = base Napierian Logarithms = 2·71828183 + &c.
x, x' = any ordinates to curve parallel to axis x reckoned from the lowest point of curve.
y, y' = any ordinates to curve reckoned from the distance c below the lowest point of curve.

w = weight of 1 chain of riband.
T, T' = tensions at any points in curve.
τ = mean of any two values of $T = \frac{T + T'}{2}$
t = standard tension of riband.
ρ = radius of curvature at any point of curve.
θ = circular measure of any angle.
ζ, ζ' = any angles between axis y and any chord of the curve.
The fundamental equations to the catenary curve are :—

$$s = \frac{c}{2}\left(\epsilon^{\frac{x}{c}} - \epsilon^{\frac{-x}{c}}\right) \text{ and } y = \frac{c}{2}\left(\epsilon^{\frac{x}{c}} + \epsilon^{\frac{-x}{c}}\right)$$

III.—*Equation* $h^3 - th - \frac{l^2 w^3}{24k} = O$.

$x = \frac{l}{2}$, therefore $L = c\left(\epsilon^{\frac{l}{2c}} - \epsilon^{\frac{-l}{2c}}\right)$. By exponential theorem, $\epsilon^{\frac{+l}{2c}} = 1 \pm \frac{l}{2c} + \frac{l^2}{8c^2} \pm \frac{l^3}{48c^3} + \frac{l^4}{384c^4} \pm \frac{l^5}{3840c^5} +$ &c., therefore $L = l + \frac{l^3}{24c^2} + \frac{l^5}{1920c^4} +$ &c. $C = \frac{h}{w}$ therefore $L - l = \frac{l^3 w^2}{24h^2} + \frac{l^5 w^4}{1920h^4} +$ &c.
But $L - l = (h - t)\frac{lk}{w}$ very approximately, therefore $(h - t)\frac{lk}{w} = \frac{l^3 w^2}{24h^2}$ about, the second and omitted term on the right-hand side of this equation being very small. The effect of this omission is moreover partly neutralized by the omission of a small quantity which should be included in the left-hand side. Dividing each side by $\frac{lk}{w}$ and multiplying by h^2 gives $h^3 - th^2 - \frac{l^2 w^3}{24k} = O$.

For a length of 10 chains, weighing in all 10 lb. and standard length at a tenison of 33⅓ lb. the result given by the above equation is $h = 93{\cdot}94$ lb. The true tangential tension to be applied at either end is almost exactly 94·05 lb. The error is therefore only ·11 of a lb., a quantity that may be entirely neglected.

It has been stated that the curve may be taken as an arc of a circle without appreciable error. The following solution will make this manifest :—

$\rho = \frac{y^2}{c} = c$, very approximately, $= \frac{h}{w}$.

$\frac{L}{2\rho} = \theta$ and $\frac{l}{2\rho} = \sin\theta$.

Expanding, $\theta = \sin\theta + \frac{\sin^3\theta}{6} + \frac{3\sin^5\theta}{40} + \frac{15\sin^7\theta}{336} +$ &c.

Multiplying by $2\rho = \frac{2h}{w}$, $L = l + \frac{l^3 w^2}{24h^2} + \frac{3l^5 w^4}{640h^4} +$ &c.

The third term on the right-hand side being nine times as great as the similar term in the expansion of the equation to the catenary curve. The term is so small, however, that it may be neglected. The appreciable terms, therefore, agree exactly, whether the solution be catenary or circular.

IV.—*Equation* $\tau^3 - t\tau^2 - \dfrac{l^2w^2 \sin^2\zeta}{24k.}$

The following is a strictly accurate solution of the catenary curve at any angle :—

$$s' - s = L\ ;\ x' - x = l \sin \zeta\ ;\ y' - y = l \cos \zeta.$$

$$y = \frac{c}{2}\left(\epsilon^{\frac{x}{c}} + \epsilon^{\frac{-x}{c}}\right)\ ;\ y' = \frac{c}{2}\left(\epsilon^{\frac{x'}{c}} + \epsilon^{\frac{-x'}{c}}\right)$$

$$s = \frac{c}{2}\left(\epsilon^{\frac{x}{c}} - \epsilon^{\frac{-x}{c}}\right)\ ;\ s' = \frac{c}{2}\left(\epsilon^{\frac{x'}{c}} - \epsilon^{\frac{-x'}{c}}\right)$$

Therefore, $l \cos \zeta = \dfrac{c}{2}\left(\epsilon^{\frac{x'}{c}} + \epsilon^{\frac{-x'}{c}} - \epsilon^{\frac{x}{c}} - \epsilon^{\frac{-x}{c}}\right)$

and $L = \dfrac{c}{2}\left(\epsilon^{\frac{x'}{c}} - \epsilon^{\frac{-x'}{c}} - \epsilon^{\frac{x}{c}} + \epsilon^{\frac{-x}{c}}\right)$

Therefore, by addition $L + l \cos \zeta = c\left(\epsilon^{\frac{x'}{c}} - \epsilon^{\frac{x}{c}}\right)$

and by subtraction $L - l \cos \zeta = c\left(-\epsilon^{\frac{-x'}{c}} + \epsilon^{\frac{-x}{c}}\right)$

by multiplication $L^2 - l^2 \cos^2 \zeta = c^2\left(\epsilon^{\frac{x'-x}{c}} + \epsilon^{\frac{-x'+x}{c}} - 2\right)$

or $c^2\left\{\epsilon^{+\left(\frac{x'-x}{c}\right)} + \epsilon^{-\left(\frac{x'-x}{c}\right)} - 2\right\}$

That is $L^2 - l^2 \cos^2 \zeta = c^2\left(\epsilon^{\frac{l \sin \zeta}{c}} + \epsilon^{\frac{-l \sin \zeta}{c}} - 2\right)$

Expanding $L^2 - l^2 \cos^2 \zeta = l^2 \sin^2 \zeta + \dfrac{l^4 \sin^4 \zeta}{12c^2} + \dfrac{l^6 \sin^6 \zeta}{360c^4} + \text{\&c.}$

Therefore, $L^2 = l^2 + \dfrac{l^4 \sin^4 \zeta}{12c^2} + \dfrac{l^6 \sin^6 \zeta}{360c^4} + \dfrac{l^8 \sin^8 \zeta}{20160c^6} + \text{\&c.}$

So far the solution is strictly accurate ; but as c can only be found approximately, or perhaps more strictly to any assigned degree of accuracy, an approximative method must now be followed. If τ be the mean of the tensions T' and T, its direction will be nearly parallel to the chord l. Therefore, $\tau \sin \zeta = h$ very approximately ; and $\dfrac{\tau \sin \zeta}{w} = c.$ Hence the above equation becomes $L^2 = l^2 + \dfrac{l^4w^2 \sin^2\zeta}{12\tau^2} + \dfrac{l^6w^4 \sin^2\zeta}{360\tau^4} + \text{\&c.}$ But $L^2 = \left\{l + (\tau - t)\dfrac{lk}{w}\right\}^2 =$ $^2 + 2l(\tau - t)\dfrac{lk}{w} + (\tau - t)^2\dfrac{l^2k^2}{w^2.}$ Rejecting the final term of this last

equation as inappreciable $(\tau - t)\frac{2l^2k}{w} = \frac{l^4w^2 \sin^2\zeta}{12\tau^2} + \&c.$ Therefore, $\tau^3 - t\tau^2 - \frac{l^2w^3 \sin^2\zeta}{24k} = 0$ very nearly.

It may be observed that when $\zeta = 90°$ this equation becomes $\tau^3 - t\tau^2 = \frac{l^2w^3}{24k}$ agreeing with the equation when the ends are in the same horizontal plane.

With regard to the rejection of the term $(\tau - t)^2 \frac{l^2k^2}{w^2}$, it will prove upon examination to be of very small value, and further, the error introduced by omitting it is partly balanced by the exclusion of the term $\frac{l^6w^4 \sin^2\zeta}{360\tau^4}$.

The equation may also be arrived at by assuming the curve to be circular. Radius of curvature $\rho = \frac{y^2}{c}$ at middle of curve, about $\frac{\tau^2}{w^2c}$. $c = \frac{h}{w} = \frac{\tau \sin\zeta}{w}$ Therefore $\rho = \frac{\tau}{w \sin\zeta} = \theta = \sin\theta + \frac{\sin^3\theta}{6} + \frac{3\sin^5\theta}{40} + \&c.$ Therefore, *vide* Appendix III, $L = l + \frac{l^3w^2 \sin^2\zeta}{24\tau^2} + \frac{l^5w^4 \sin^4\zeta}{640\tau^4} + \&c.$ But $L = l + (\tau - t)\frac{lk}{w}$, therefore $\tau^3 - t\tau^2 = \frac{l^2w^3 \sin^2\zeta}{24k}$ very approximately.

IV.—*Equations* $T_1{}'T = t + (h - t) \sin\zeta \pm \frac{lw \cos\zeta}{2}$.

These formulæ are inexact, but are sufficiently accurate for ordinary purposes, and their convenience for purposes of computation is obvious. The error for a 5-chain riband, weighing in all 5 lb., suspended at an angle of 30° from a horizontal line, and standard length at a tension of $33\frac{1}{3}$ lb., is only about ·13 lb., and for a 10-chain riband about ·88 lb. At an angle of 60° the errors are 1·26 and 1·36 respectively; and as these are the extreme errors in a very heavy riband, the equations may very safely be used in all ordinary circumstances.

V.—*Equations* $\tau = \frac{l^2w^3}{24t^2}$ and $\tau = \frac{l^2w^3 \sin^2\zeta}{24\left(t \pm \frac{lw\cos\zeta}{2}\right)^2}$.

$L - l$ is evidently the correction, and in Appendix III this was shown to be $\frac{l^3w^2}{24h^2}$ very approximately, and h and t are equivalent. In Appendix IV, it was shown that $(\tau - t)\frac{2l^2k}{w} = \frac{l^4w^2 \sin}{12\tau^2}$ very

approximately. Dividing by $2l,(\tau - t)\ \frac{lk}{w} = \frac{l^3w^2 \sin^2\zeta}{24\tau^2}$. But the left-hand side of this last equation $= L - l$, which is the correction in the direction of the chord. $\tau = t \pm \frac{lw \cos \zeta}{2}$ according as the tenison is applied at the lower or the upper end of the riband. Therefore $\frac{l^3w^2 \sin^2\zeta}{24\tau^2} = \frac{l^3w^2 \sin^2\zeta}{24\left(t \pm \frac{lw \cos\zeta}{2}\right)^2}$. To reduce this quantity to its horizontal value, it must evidently be multiplied by the sine of the zenith distance or angle. Thus the $\sin^2\zeta$ is simply converted into $\sin^3\zeta$.

VI.—*Correction for Temperature in steel tapes.*

It has been suggested that the correction for temperature may be compensated by varying the tension of the riband, when supported throughout its entire length. Assuming 1·00115 as the coefficient of expansion for 180° Fahr., and ·00000779 as the extension for 1 ℔. tension, the following expression for the compensation may be deduced:—If Δt and Δf = differences of tension and temperature $\Delta t = \cdot 8203 w\ \Delta f$. From this equation it is evident that a riband weighing 1·2191 ℔. per chain would require a difference of 1 ℔. in tension for every change in temperature of 1° Fahr., and therefore the compensation is practicable with only the very lightest ribands.

VII.—*Table of Tensions to be applied to a Wire Riband weighing 1 lb. per chain, and standard length at a tension of* $33\frac{1}{3}$ *lb.*

Length suspended.	Angle of chord of Riband from horizontal line. +0°–	+10°–		+20°–		+30°–		+40°–		+50°–		+60°–	
chains	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1	37·20	37·19	37·02	37·01	36·67	36·62	36·12	36·1(	35·46	35·51	34·74	34·89	34·03
2	44·26	44·21	43·87	43·72	43·03	42·80	41·80	41·5(	40·21	39·88	38·35	38·07	36·33
3	51·49	51·43	50·91	50·71	49·69	49·36	47·86	47·40	45·47	44·88	42·58	41·93	39·33
4	58·41	58·35	57·66	57·46	56·09	55·75	53·75	53·23	50·66	49·95	46·89	45·99	42·52
5	64·99	64·94	64·07	63·90	62·19	61·87	59·37	58·87	55·67	54·92	51·09	50·07	45·73
6	71·26	71·22	70·18	70·05	68·00	67·74	64·74	64·30	60·45	59·74	55·15	54·09	48·89
7	77·25	77·23	76·02	75·95	73·55	73·39	69·89	69 65	65·15	64·42	59·06	58·03	51·97
8	83·01	83·02	81·63	81·63	78·89	78·83	74·83	74·61	69·47	68·97	62·84	61·88	54·95
9	88·56	88·60	87·04	87·11	84·04	84·09	79·59	79·52	73·74	73·38	66·49	65·64	57·85
10	93·99	94·00	92·27	92·43	89·01	89·20	84·20	84·29	77·86	77·68	70·02	69·32	60·66

NOTE.—The standard tension and the tensions for the different lengths suspended for riband of any other *weight* may be found by proportion, or by multiplying the quantities in the table by the weight of 1 chain of the riband, expressed as a fraction of a pound

VIII.—*Table of Values for* τ *in the Equation* $\tau^3 - t\tau^2 - \frac{l^2 w^3 \sin^2 \zeta}{24k} = 0.$

Altitude 0°.	t = 20.	t = 25.	t = 30.	t = 35.	t = 40.	t = 45.
chains	lb.	lb.	lb.	lb.	lb.	lb.
1	27·22	30·68	34·50	38·59	42·91	47·38
5	58·75	60·97	63·34	65·84	68·50	71·30
10	88·42	90·42	92·51	94·67	96·93	99·27

Altitude 30°.	t = 20.	t = 25.	t = 30.	t = 35.	t = 40.	t = 45.
chains	lb.	lb.	lb.	lb.	lb.	lb.
1	26·27	29·59	33·56	37·81	42·24	46·83
5	54·18	56·46	58·90	61·51	64·28	67·21
10	81·06	83·10	85·23	87·46	89·77	92·20

NOTE.—$w = 1$ lb. : $k = \cdot00000779$ chain : $l = 1$, 5, and 10. $\zeta = 90°$ and 60°.

This table may be used for interpolating the tensions with any standard tension from 20 to 45 lb. for riband weighing 1 lb. per chain. For riband of any other weight the tension for both the supported and the suspended ribands will be proportionate, and may be found by multiplying the quantities in the table by the weight of 1 chain of the riband, expressed as a fraction of a pound.

Notes on Flying-machines.

By Lawrence Hargrave.

[*Read before the Royal Society of N.S.W., 3 June, 1885.*]

Since last reading a paper to this Society, I have been making further experiments with trochoided planes, and my attention has been directed principally to the question whether the speculations that were made about the flight of birds are correct, and if so, can a mechanical contrivance be constructed that would show what my views on the subject are.

I have been unsuccessful in all attempts at vertical flight, and am disposed to modify the opinion expressed on that point, as it is evident that some birds when hovering use the same motion that they do when flying horizontally. This we can see in the small birds that suck honey from flowers when on the wing, the body is kept vertical and the waves thrown downwards.

With horizontal flight, more success has attended my efforts; and experimenting with nearly fifty models has resulted in these that I hope to show you supporting themselves and moving horizontally in such a way that if the motion is not that used by birds, it is at all events very like it, and its acceptance or rejection as a scientific truth is of no further interest, as it only remains for practical mechanics to step in and adjust the details to suit the material and motive power they may think best for the purpose they have in view; or, in other words, that the solution of the problem of how a bird flies is of very trifling importance from a utilitarian standpoint, compared with the judicious variations of the parts of this machine that will have to be made before any return can be expected for money invested in such undertakings.

Mr. Russell suggested to me that trial should be made with india-rubber as a motive power, and it has thus been possible to make an engine the weight and power of which approximates closer proportionally to the large engines we shall use than the clock-work previously experimented with.

The flying models exhibited at the conversazione last October showed partly what I was attempting, but they grossly failed in the most important point, viz., they were all supported either by strings or on wheels, and therefore could not be defined as flying-machines any more than those machines that depend for their success on floatation by the aid of gas.

The rough workmanship is found to be of comparative unimportance compared with the adjustment of the planes, but repeated failures have brought out a slight improvement in the execution, and several interesting results.

It is necessary to see clearly that these machines are identical in principle with the model previously exhibited and described, that had two vertical planes that were trochoided in water. The plane of the body and tail represents one of the vertical planes, and the equivalent plane of the two wings the other. At a casual glance they seem totally dissimilar; a closer analysis will make it evident that they are one and the same mechanism.

The equivalent plane, as I term it, is an imaginary surface trochoided by an imaginary crank and connecting rod, that throws a wave equal in section and pitch to the mean of the infinite number of waves thrown by the two wings that are trochoided radially. The section of the wave of the equivalent plane is a rectangle, that of each wing plane is a sector of a circle. By the way, if the trochoided plane ever comes into general use, some ingenious person will contrive a movement by which the crank and connecting-rod are embodied in the universal joint of radially trochoided planes, but for rough experimental work such as this, it has been found most convenient to put the connecting-rod at a distance from the universal joint sufficiently great to ensure tolerably exact adjustment of the work that I am capable of doing.

The experiments show that the greater surface of each plane ought to be abaft the plane passing through the shaft and the guides, apparently for the same reason that the after part of a balanced rudder is made of greater area than the forward part, viz., the formation of vortices behind each edge of the rudder when put over, and the impinging of more effective streams of water on the forward than on the after part; because those streams that would if uninterrupted strike the afterpart do not touch the rudder at all, but strike the surface of the streams deflected by the forward part.

For the same reason, if a boat is towed on an even keel it is difficult to keep her straight—she will yaw, and if not met, will take a broad sheer suddenly and dangerously; if she is brought by the stern and sheered by the rudder the greater number of partially effective streams striking the after part of the boat have a greater combined effect than the smaller number of highly effective streams striking the forward part of the boat, and if the helm is righted she returns of herself to the course, and keeps it.

The proportion that the after part of the most efficient trochoided plane bears to the forward must therefore be closely dependent on the pitch. For fine pitches it will be found best to make the forward part small, and for coarse pitches to make the two parts nearly equal, the after one preponderating, this puts a torsional

strain on the midrib and a bending strain on the connecting-rod; also, if the web of the plane is rectangular and the midrib central, the centre of effort of the equivalent plane will be at about a third of the web from the end; and if the midrib is shifted to the forward edge of the rectangular web, the torsional strain on a regularly tapering midrib will twist the web into a portion of the surface connecting two straight lines on two parallel planes, the two straight lines not being parallel to one another. The effect on the trochoided plane will be to shorten the pitch of the equivalent plane and bring it nearer the geometrical centre of the web. This seems advantageous, without taking into account the frequent repairs necessary to the web when the midrib is placed as in the earlier models. You will observe that all the later models have no web in front of the midrib, and one of the crossbars is left projecting forward to act as a strut to the guys that tauten the web.

At first I thought it possible to make the body plane so large that it could be propelled by the trochoided wings in a straight line, but it is found that, however great the disproportion be between the planes, they will move towards and from one another inversely as their areas (the weight of the planes being also a term in the equation), and that a phenomenon we see when making ducks-and-drakes or throwing a flat object edgeways comes into play. You have doubtless noticed that, as long as the object is gyrating rapidly, the plane of gyration is carried forward parallel to the plane in which it left the hand, but as the spinning decreases in rapidity the object will scoot off either upwards or downwards, bringing its largest section at right angles to the direction of impulse. The reason seems to be that the gyration throws a current of air radially with sufficient force to prevent a vortex being formed above the edges of the object as it is being dragged downwards by gravity in a direction at right angles to the plane of gyration. When the vortex is once formed, either above or below the leading edge, the streams of air act on the opposite side of the object the same as the water does on the balanced rudder or towed boat. Now, if the body plane is made so large that its motion towards and from the wing plane is very small, it will need extreme care to get the pressure on both sides alternately, and if this is not done the machine will act the same as the flat object.

The machine is more easily adjusted by having the body plane in two parts, and much longer than it is wide. A very small piece cut off the tail makes a machine that flies downwards into one that flies horizontally or upwards, and a piece cut off the head makes one that flies laboriously upwards into one that flies rapidly horizontally. If the area of the body plane is collected into an equal compact figure, the machine will sometimes turn head over heels. Some of these short-tailed ones will probably do so if they don't

strike the wall. I purpose selecting the best of these models, and making their mean dimensions a standard from which to take a fresh departure.

Each wing has been made to have a stroke of 90°, but in short wings this may be largely increased with advantage, as we see several kinds of pigeons even striking their wings together; long-winged, swift-flying birds use an angle much less than 90°.

At first I stretched the india-rubber from aft forward, but in most of these models it is stretched from forward aft. The reason for the alteration is that, as the india-rubber contracts, the centre of gravity of the machine is shifted towards the fixed end of the india-rubber; and if there is power sufficient to propel the machine upwards at starting, we want the centre of gravity moved forward to decrease the angle of elevation as the power of the elastic decreases.

Another note-worthy point is, that the fore-and-aft members of the planes are placed underneath the web, and the tranverse ones above it.

The distance these models fly seems very trifling, but experience teaches us that in all model-experiments increase of proportional size and weight bring universally better results in work done.

It has been found impossible to form even a moderately exact determination of what distance or height the machines actually fly; the circulation of the air in a room like this causes currents that tilt the wings or tail so that the action is different at each trial.* Out of doors accuracy is still more impossible until we make the machines much larger, and consequently less fragile. A wing torn and patched again of course renders all previous trials valueless for comparison: and besides all this, whatever care is taken not to project the machine in the direction it is wished to go, there is still probably an involuntary movement of the hand in that direction which you will perhaps detect.

The speed attained shows us that when we come to deal with machines weighing tons instead of ounces we shall have also to deal with air-pressures exceeding hurricane force, with which the edges of trochoided planes are in my opinion the only things that can successfully cope.

The steering of flying-machines on this principle requires a rapidity of thought and action that will at first tax the nerves to the utmost, but in one-man machines practice will reduce the movements of the body necessary to alter the centre of gravity to the various requirements to as simple an act of volition as skating

* NOTE.—The reason the majority of the machines turned so unexpectedly upwards on reaching the centre of the room, though not noticed at the time, is now seen to have been that the main current of air was circulating upwards in the centre and downwards at the walls.

or riding a bicycle. In larger machines this will have to be done by making the area of the tail variable for ascending or descending, and tilting one corner up or down for turning to either side.

The ascending and descending may also be managed by making the framing between the universal joint and the crank shaft variable in length. By increasing this distance, more than half the arc through which the wings move is brought below the body plane, so that if the machine was previously balanced for horizontal flight the alteration will make it ascend.

Likewise the turning may be effected by making the upper end of one connecting-rod fast to a sleeve sliding on the midrib. The position of the sleeve determines the arc of that wing measured from the body plane, but the two wings will still make equal arcs with the horizon as the body will be rocked from side to side.

Regarding the proportion of weight to area, the models are comparable more to butterflies than to the majority of flying organisms, but these experiments seem to show that by means of the trochoided plane the same power will propel equal weights the same distance, provided the rapidity of the motion of the wings is increased proportionately to the reduction in the sectional area of the waves thrown; or, that a beetle and a moth of equal weight expend the same amount of strength in flying the same distance, and the result is produced by throwing the same number of cubic inches of air in each case.

It takes 14 lb. to stretch one of these red elastic bands 10 inches; that is, when they are looped so that there are four folds of the india-rubber. There is one movable sheave introduced, so that the barrel is turned by about 7 lb. when the machine is wound up tight.*

The pitch of the equivalent plane when the connecting-rod equals 2½ cranks is about 75 inches when arranged as in that model with the long tail, which is one of the oldest and least efficient I have, the proportion now used is the crank equals one-third the connecting-rod. These results are arrived at by a system of selection; those machines that fly at all have been kept till some slight improvement, suggested by experience or judgment, has been embodied in the next ones, the older machines are then broken up or altered. It is found that this experimental method is more fruitful than attempting to make any elaborate calculations, although differently constituted minds may find the latter way the best.

* NOTE.—A marked improvement has since been made by making the barrel flat instead of cylindrical, the crank-shaft has now a uniform rotary motion, and there is a total absence of that jerk that was so conspicuous as the crank pins passed the centres; the motive power is also much economized.

In making experiments with flying-machines on a large scale, it is well we should understand that the generation of steeple-jumpers has passed away, and that any one at the stage our knowledge has attained to, who tries his machine first from an eminence, richly deserves any accident that may befall him. The method of starting must be, as suggested somewhere in Mr. Proctor's writings, from a light carriage on a level or falling gradient. If the machine is correctly proportioned it will leave the carriage at the proper moment; if anything is wrong, no accident can happen to the experimenter.

The carriage will need three wheels on castors, with one upright bar rove loosely through the machine, so that all manœuvres may be practised without allowing it to rise higher than the top of the bar, and with perfect safety to both the machine and the man.

The motive power most suitable for flying-machines is air compressed into spherical or spindled-shaped steel vessels, driving a direct-acting single-cylinder oscillating engine. (*Diagram* III.)

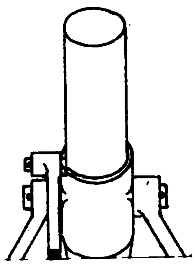
It is perhaps premature to speak of alighting before we ascend at all; but we may take a lesson from birds, and observe how they turn round and face the wind when coming to the ground, in the same way that a yacht picks up her moorings.

The every-day employment of flying-machines as means of transit would be brought much nearer in point of time if our boys would make and use these models as toys; they require little more skill in construction than an ordinary kite, and young brains are so much readier to perceive and grasp an improvement than those that have already been moulded and set in a particular groove.

I will now wind up the machines and let them speak for themselves, and if they do not all break in winding (a not unusual accident), they will perhaps carry conviction to some mechanical minds that by means of a ridiculously simple piece of mechanism rapid artificial flight is possible.

If one of them threatens to strike any gentleman present, would he kindly hold up his hands—so—this will stop the flight, and the machine will fall harmlessly to the ground, and will probably escape unbroken: if you attempt to hold it, it is sure to be damaged.*

* NOTE.—Diagrams II and III are not introduced as drawings purporting to be accurately proportioned, but to convey to the eye of an engineer my idea of how certain causes can produce certain effects; in this case, how compressed air is to trochoid flat wings.



On a form of Flying-machine.

By L. HARGRAVE.

[*Read before the Royal Society of N. S. W., 2 December, 1885.*]

I HAVE brought these observations before you in the hope that they may be of use to others who are attacking the problem of artificial flight. I do not assume that they are in any way conclusive, for it must be obvious to any one who observes nature, be it ever so little, that the combinations of weight, strength, and area that produce flight are infinite, but as showing from actual experiment what power propels a weight of known area for a known distance; a number of such observations are necessary to determine the formula by means of which we can design the machines and predict their performances.

This machine has a spread of wing of 7 feet 2 inches; the area of the wings is 378 square inches; the length of body and head is 6 feet 1½ in.; the area of the body and head is 858 square inches; the total weight is 1·47 lbs.; this gives an area of 840 square inches per lb. weight.

Now as to the motive power. The strut forms the back-bone of the whole concern; it is about 1¼ in. square, and is hollowed out to about the thickness of cardboard, and you could easily flatten it between your fingers and thumb; it is made of clear pine, and at 5,400 lbs. per square inch would stand 3,051 lbs. end compression if it did not buckle; it is tapered slightly towards the tail.

The twenty-four elastic bands weigh 5 ozs., and each is stretched with a force of 12·6 lbs. to 30⅝ inches; and in the manner they are arranged puts a thrust of 189 lbs. on the strut.

The purchase by which the elastic bands are stretched is a luff tackle; the sheaves are ivory, and about 1¼ in. diameter; the cord is white hemp fishing-line, and breaks with 67 lbs.; the theoretical strain on the fall is 37·8 lbs., but experiment with a Salter's balance on the string proves there is only 30 lbs., the rest being lost in friction at the four sheaves; this strain decreases, as the india-rubber bands contract at the following rate:—

1st flap ...	... 30 lbs.	5th flap ...	... 19·2 lbs.
2nd „ ...	... 26·8 „	6th „ ...	... 17·5 „
3rd „ ...	... 24 „	7th „ ...	... 15·6 „
4th „ ...	... 21·7 „	8th „ ...	... 14 „

G

These quantities are measured from fig V with a bastard scale, 30 units of which are equal to AB; their sum multiplied by the length of cord overhauled at each flap, viz. 1foot, gives 168·8 ft. lbs. as the amount of work done during the flight by the bands.

The cord is wound on a flat winder 6 inches long; the crank shaft is at the centre of the winder, and the cranks are on either the top or bottom centre when the winder points to the last sheave over which the cord passes, that is, they are not quite at right angles to the winder. The strain on the crank pins due to the flat winder, varies as the cosine of the angle the winder makes with the line joining the centre of the crank-shaft and the last sheave over which the cord passes.

From the centre of the crank shaft to the centres of the crank pins is 1·4 in., the crank pins are spherical, and the connecting rods are 4·65 inches long, which gives a pitch angle of $72\frac{1}{2}°$. The upper end of each connecting rod is fastened to the midrib at 1·61 in. from the socket, and each wing moves through an arc of 121°.

The centre of effort of each wing is 25·5 inches from the socket, and the length of the arc traversed by it is 53·8 inches, which is taken as the height of the equivalent trochoidal wave.

The midrib is 3 inches from the forward edge of the wing, which is 9 inches wide, and the preponderance of the after part of the wing membrane twists the midrib about 15°; this shortens the equivalent trochoidal wave to 22·08 feet, and makes the pitch angle $57\frac{1}{2}°$.

The distance the machine flew was 98 feet from where I stood, it took a wide sweep of at least 30 feet versed sine, making 120 ft. on the curve; it was stopped by a fence on the top of which it caught, 8 feet below the starting-point; the trajectory was slightly ascending at first, but very little.

The wings are flapped ten times in 7 seconds, which gives a horizontal speed of 14·6 miles per hour, or 15 feet per stroke.

Using the formula $P=0{\cdot}002288\ V^2$ where $P=\cdot177$ lbs. per square foot pressure on the membrane due to the weight of the machine, and V will equal 8·8, which is the number of feet it would fall in each second if the membrane were kept horizontal; so that during the time of flight it would fall 49·28 feet; but during the same time it is translated 120 feet horizontally and 8 feet downwards, so that by the parallelogram of forces the india-rubber bands drive the machine upwards at an angle of 19° for a distance of 126·5 feet; this gives 15·8 feet per stroke, and a slip of 28·4 per cent. which represents the skin resistance.

The strain on each crank-pin at the centre of the first stroke is 32·15 lbs., or 2·02 lbs. on each wing's centre of effort; this strain decreases to 0 when the crank is on the centre and the winder pointing towards the last sheave. The angle of the wing with the direction of the thrust, and the torsion of the midrib, decrease with

the strain on the crank-pin. When these are plotted as in fig. I and resolved into thrust and useless work, which are plotted again in the two curves of fig. II, the areas enclosed by the curves will represent ft. lbs. for $\frac{1}{4}$ of the first revolution of the crank-shaft from which is deduced the mean lbs. of thrust of both wings for the first revolution = 1·075 lbs., and mean lbs. of lost work of both wings for the first revolution = 2·26 lbs. Multiplying each of these quantities by 9 feet, the distance traversed by the centre of effort of the wing gives 9·675 ft. lbs. of effective work and 20·34 ft. lbs. of lost work, the sum of which, 30·015 ft. lbs., is the work of the first stroke.

The effective work and the lost work decrease for each flap proportionally with the scale of strains on the fall previously given, which sums up to 168·8 ft. lbs., and the actual work done by the machine during its flight is shown by fig. IV to be 41·28 feet, multiplied by 1·47 lbs. = 60·68 ft. lbs.; but the whole work of the first stroke is to the effective work of the first stroke as the total work of the elastic bands is to the total thrust of the eight strokes, that is, as 30·015 : 9·675 :: 168·8 : 54·4, giving a difference of 6·28 ft. lbs., to which I attach little importance, as it may arise in a number of ways from the graphic method of investigation adopted.

The centre of gravity of the machine when wound up is 2 feet 5 inches; the centre of gravity of the machine when it has made 8 strokes is 2 feet 2 inches; the mean centre of effort is 2 feet 9 inches; all measured from the forward end of the strut.

Fig. VI refers to the strength of the tissue paper that is used for the membrane of the planes; it took over 28 lbs. to burst the four compartments; the pressure was applied on the four circles shown, each $2\frac{3}{4}$ inches diameter; the fractures took place along the lines sketched in. The rigidity and lightness of the paper make it extremely suitable for the membranes; muslin has been tried, but it bellies, and is hard to stretch tightly.

There have been so many breakages and ambiguous results due to the wind, that I now never try a machine unless it is perfectly calm; I find just before sunrise the only time it can be said air currents have no effect on the observations. The experiment described may be taken as considerably under what the twenty-four india-rubber bands would do if the machine were more carefully made; and fig. V shows they can be stretched to 38 inches with a strain of 20 lbs., in this experiment they were only stretched to $30\frac{5}{8}$ inches, with 12·6 lbs.; but many of the india-rubber bands would not stand more than one or two of the long stretches, and accidents would be frequent.

It has occurred to me that the motion of this form of flying machine will produce sea-sickness, time will show if this is correct.

From a consideration of the observations it may be theorized that the same horizontal flight is produced—

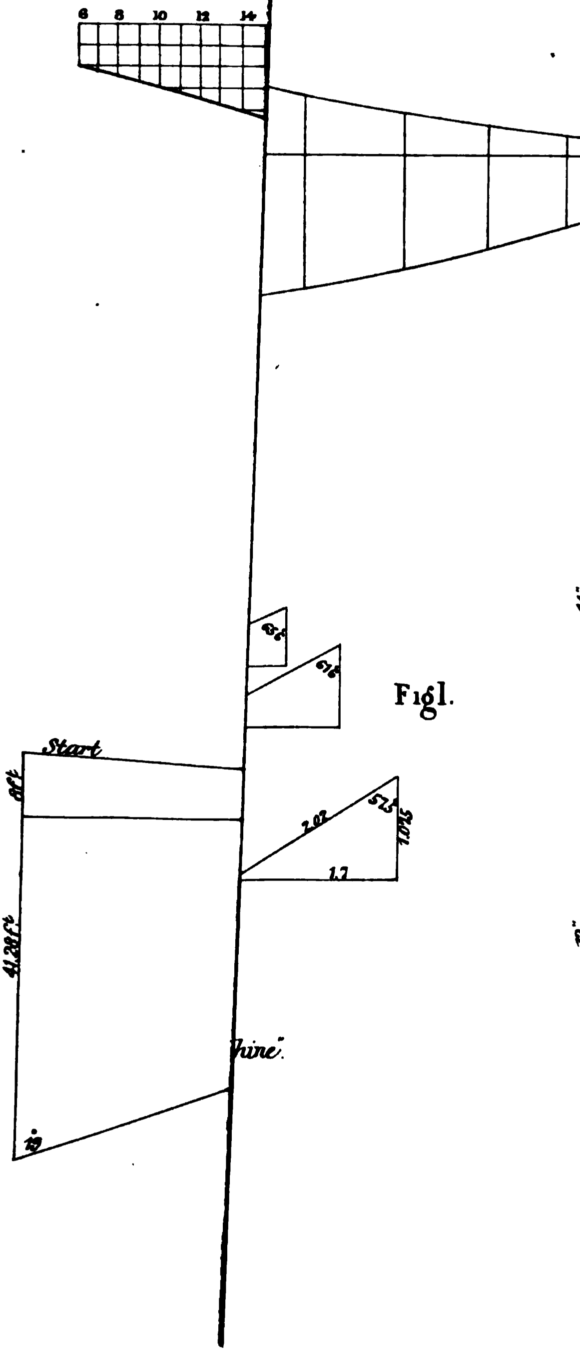
1st. If the area is reduced the power can remain the same, but the weight must be reduced.

2nd. If the area is reduced the weight can remain the same, but the power must be increased.

3rd. If the weight is reduced the area can remain the same, but the power must be reduced.

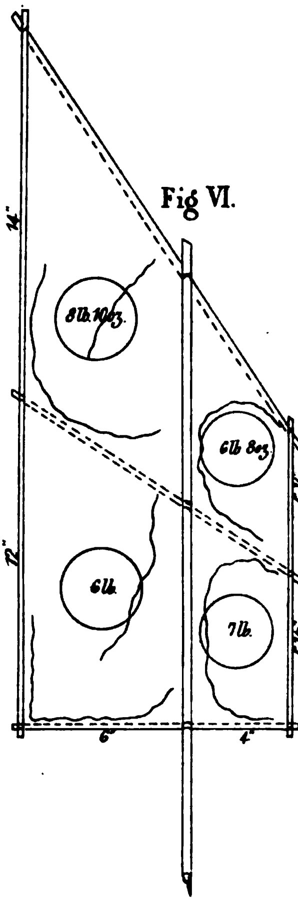
4th. If the power is reduced the weight can remain the same, but the area must be increased.

[Seven diagrams.]



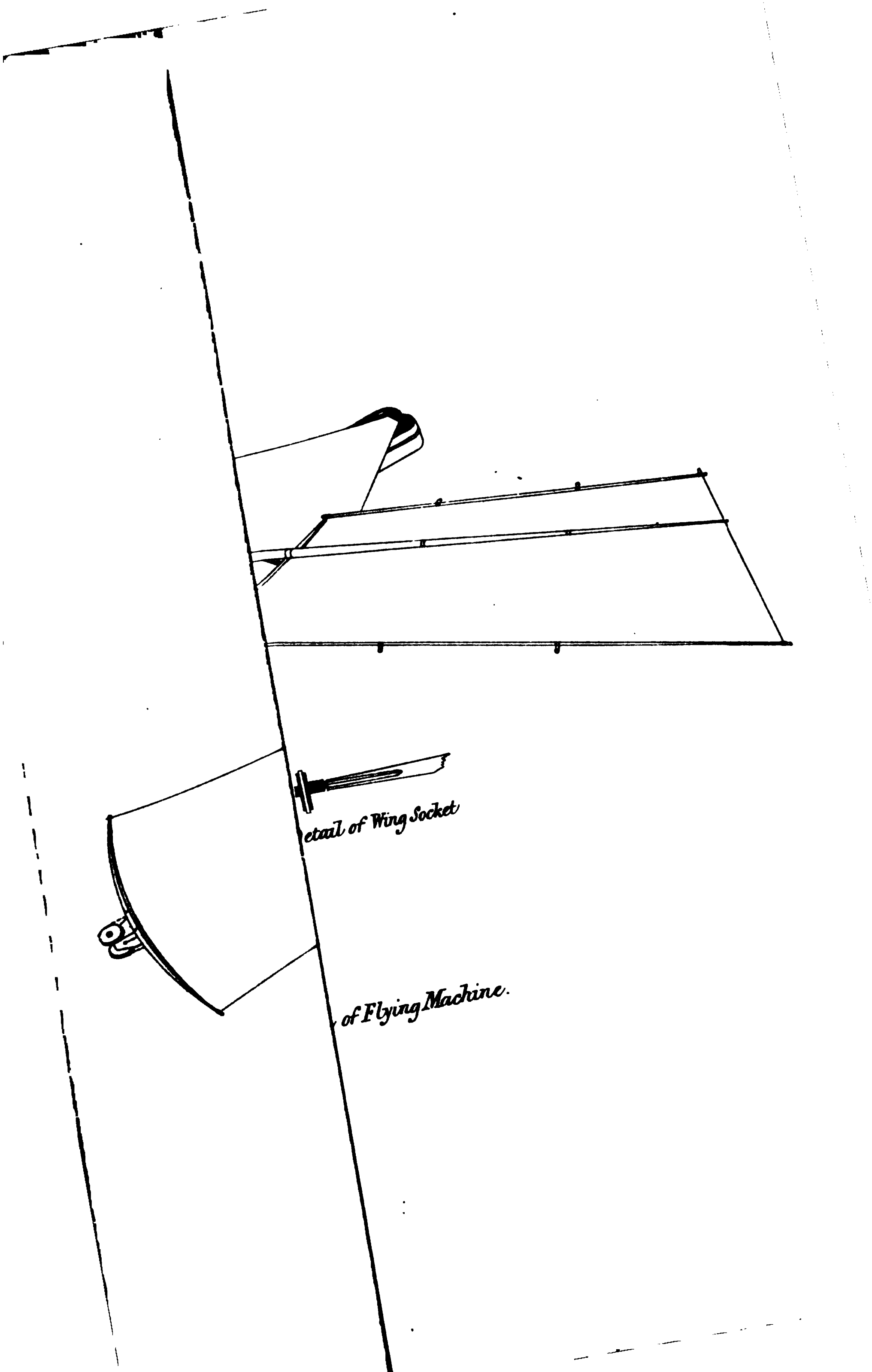
6
8
10
12
14
Start
8ft
41.28ft
2.07
52.5
1.045
1.7
hine".

Fig I.



14"
12"
8lb.10oz.
6lb 8oz.
6lb.
7lb.
5½
5½
6"
4"

Fig VI.


etail of Wing Socket
of Flying Machine.

Local Variations and Vibrations of the Earth's Surface.

By H. C. Russell, B.A., F.R.A.S.

[*Read before the Royal Society of N.S.W., 1 July, 1885.*]

As the network of science closes round the phenomena of Nature, every now and then some new fact is found protruding itself, which upon examination suggests a new line of investigation, or a readjustment of that which has gone before. An illustration of this is, I think, found in the recent investigations into earthquake phenomena in Europe, and especially in Italy, which make it quite evident that the astronomer can no longer trust to the stability of the earth's surface as he has done in the past, but must investigate the effects of these changes upon his instruments, if he would attain to that perfection in observations which his science demands. He must now recognize the fact which the geologist has proved, that the earth's crust is in a chronic state of vibration and change, to an extent probably sufficient to explain some of those troublesome errors which have been heretofore set down to instability in the instruments or change in the observers.

In 1878 a Committee of the British Association was appointed to measure the lunar attraction, or rather its effect upon the solid part of the earth. Theoretically the moon should produce a tide in the rocks as well as in the ocean, for, solid as they seem, they are still quite flexible enough to admit of such a change in form as the lunar attraction causes, without fracture; the change, though sensible and important, and even measurable from an astronomical point of view, is yet quite inappreciable to an ordinary observer.

The Committee were fully alive to the difficulties of their task, but, when fully considered, these seemed to be no greater than would serve as a healthy stimulus to men who meant work.

The Committee consisted of Sir William Thompson, Professors Tait, Grant, Purser, and Forbes, Dr. Siemens, Mr. Horace Darwin, and Mr. G. H. Darwin, who made the experiments and in whose name the report is written.

The report is in two parts, vols. for 1881 and 1882 of the British Association Reports, and is of the utmost importance to astronomers. The Committee at first thought it would be possible to arrange such apparatus that the lunar effects could be seen. Sir William Thompson suggested the method of testing the question, viz., by hanging a pendulum on a very firm support, and

providing apparatus to show the slightest variation in its position with reference to the vertical. This was done by attaching the bottom of the pendulum to a small mirror hung on two silk fibres, the means of connection being a single fibre of silk. The first experiments showed how exceedingly sensitive this arrangement was, and that it was useless to attempt anything in the laboratory at Glasgow, owing to the proximity of a busy city, the want of proper appliances, and the imperfections of the first instrument. All these difficulties were overcome and the instrument set up at Cambridge, and finally made so sensitive that it would reveal a motion in the pendulum equal to an angle of 0·01″, or an inch in 348 miles; and if the changes were sudden, half of this amount could be seen. As the computed effect of the moon is equal at Cambridge to a maximum change of 0·029″, the instrument was quite capable of doing the work before them; but most unexpected difficulties arose. Nothing could be done if any one was in the room with the apparatus; if the observer lifted one foot off the ground the spot of light went flying on the scale, showing that a slight change of weight on the surface of the ground near the instrument affected the level of the ground and thence the pendulum. To avoid this a telescope was put through the wall and the changes observed through it. After this it seemed probable that they would be able to attain the desired object, and actually measure the lunar attraction, as it pulled the pendulum on one side. But here the city traffic, railways, &c., and other minor vibrations due probably to earth tremors, became so troublesome that it was impossible to distinguish certainly the lunar effects from the others. At times it would be possible to get readings satisfactorily, and at others the observers saw a distinct diurnal period, with a maximum about noon when the pendulum stood furthest northwards. The path of the pendulum was, however, interrupted by many minor zigzags, and it would sometimes, when moving steadily in one direction, reverse for an hour and go the other way. During four days the mean position of the pendulum travelled southwards so much that the spot of light went off the scale three times, but on the fourth night the pendulum took an abrupt change and moved northwards, and the following day the dance of the image was greater than usual, and then a few days later it was quite remarkable for its steadiness.

Still there was hope that with an instrument embodying the results of their experience, and an observatory in a deep mine or at a distance from a city, they might be able still to measure the moon's effect. Finally, however, the attempt was given up as hopeless, because Mr. Darwin, by computation, proved that the variations of atmospheric pressure in extreme cases, *i.e.*, where the difference amounted to 2 inches, would cause a change in the earth's surface, bulging it in or out, so that changes in the vertical

amounting to 0·0292″ would occur from time to time; and as this took place very frequently, and was greater than the lunar effect, there was no hope of eliminating the latter.

I think this conclusion is to be regretted; for although there can be no doubt about the accuracy of the figures, yet had their spot of light been made to record all its changes, it is probable that in many cases it would have been possible to separate one effect from the other as depicted in the automatic record. My experience at Lake George strengthens this view of the question.

Mr. Darwin has given in the report a most valuable epitome of the labours of other experimenters in the same field, and I will ask your attention to several of the items which have special significance in reference to what I have to bring before you to-night.

It states that M. Bouguet de la Greye made observations on a free pendulum when he was at Campbell's Island, in lat. 52° 34′ south, and he found that the long swell of the ocean breaking on the island caused a change in the vertical of 1·1″; and that M. d'Abbadie, in order to test these changes, built in 1863 a very massive stone cone 26 feet high, which rested on the solid rock about 24 feet from the surface of the ground; in this cone was a well-hole 3 feet in diameter, and this was carried down into the rock 6 feet 6 inches, making the depth of the well-hole 32 feet 6 inches. This structure was allowed to stand five years to get settled, and then a basin of mercury was placed on the bottom, and regular observations taken by means of a telescope fixed in the top. Frequently the mercury was so disturbed by vibration that nothing could be seen in it. At times he saw sudden changes of the vertical, amounting to 0·49, and even as much as 0·65. Microscopic earthquakes were frequently seen, in some of which the changes were so great that the reflected image was carried out of the field of view, and as the tide rose and the weight of water accumulated on the shore 430 yards distant, he could distinctly see the vertical line change.

During the years 1867 to 1872 he found the plumb-line deviate northwards during the latter months of the year, in every year except 1872, when it deviated to the south. The greatest sudden change he saw amounted to 2·4″ in the direction of the vertical in 6¼ hours.

M. Plantamour, who worked for years in the same field, used a very delicate level fixed in a cellar, and at right angles to the meridian. The observations revealed a diurnal oscillation, in which the east end of the level was highest about 5·30 p.m., and the change once ran up to 8·4″, 11·2″, and 15·75″ on three successive days. In addition to these diurnal motions, he noted a gradual rise in the east end, and he remarks that the east piers of transit instruments rise in the same way, but not to so great an extent.

In observing other levels placed north and south, he found a diurnal motion with a maximum about noon, the north ends rising; the annual change in these levels only amounted to 4·89″ while east and west it amounted to 28·08″. He mentions one transit instrument in which the east pier rose 23″ and had an azimuthal change of 75″, and that similar changes were observed in the transit instrument at Berne.

At Polkova, on May 10th, 1877, at 4h. 16min. a.m., when M. Nyren was observing the level of the transit instrument, he saw it begin to move, and every 20 sec. for three minutes the bubble swayed backwards and forwards, showing that changes amounting to from 1·5″ to 2·0″ were taking place and he calls attention to the fact that 1h. 14m. earlier the great earthquake at Iquique took place.

Mr. Darwin adds—"Our experiments with the plumb-bob, as far as they go, confirm the results of M. d'Abbadie and M. Plantamour, and we think there can be little doubt that the surface of the earth is in incessant movement, with oscillations extending from a fraction of a second to a year.

"M. Plantamour speaks as though it were generally recognized that one pier of a transit circle rises during one part of the year and falls at another; but if this be so throughout Europe, we must suppose that there is a kind of tide in the solid earth produced by climatic changes, the rise and fall of the central parts of continents must then amount to something considerable in vertical height, and the changes of level on the easterly and westerly coasts of a continent must be exactly opposite to one another. We are not aware that any comparison of this kind has been undertaken. The idea seems of course exceedingly improbable, but we understand it to be alleged that it is the eastern piers of transit instruments in Europe which rise during the warmer parts of the year. Now if this be generally true for Europe, which has no easterly coast, it it is not easy to see how the change can be brought about except by a swelling of the whole continent."

A subsequent part of the report refers to the work done in Italy in the investigation of earth tremors, where it has been proved that there are periods lasting from a few days to a week or even more, in which the soil is in incessant movement, followed by a comparative cessation of such movement; this he calls a seismic period. In the midst or at the end of one of these periods there is frequently an earthquake.

These periodic motions are influenced by the state of the atmospheric pressure. M. Poey attributed the variations of the vertical to this course, and M. Rossi says—"During three years no marked depression of the barometer has occurred without having been immediately preceded, accompanied, or followed by marked seismic movements."

Cavallere used ten pendulums of graduate lengths, and found that sometimes one of the pendulums and sometimes another was set moving by a seismic disturbance.

The position of the sun and moon have some influence, but the seismic motions are especially frequent when the barometer is low. The maximum disturbance occurs near the winter solstice, and the minimum near the summer solstice.

Mr. Darwin continues—"I have seen nothing which shows that M. Plantamour takes any special precautions with regard to the weight of the observer's body, and it would be interesting to learn whether any precautions have been taken for equalizing the temperature of the level itself. The slow molecular changes in glass render levels untrustworthy for comparison at considerable intervals of time. Although we must admire M. Plantamour's indomitable perseverance, it is to be regretted that his mode of observation is by means of levels; and we are compelled to regard, at least provisionally, these enormous changes of level either as a local phenomenon, or as due to systematic error in the mode of observation."

I have quoted a few of the results already obtained, by way of introduction to what I have to say this evening, and to indicate the importance of such investigations in reference to astronomical work; for if the astronomer must recognize the fact proved by the geologist and his own observations that the earth's surface is no longer to be trusted when he requires a foundation for his instruments, it becomes of the utmost importance that he should, without delay, ascertain the character and amount of these small changes, and in this way eliminate another disturbing element from his investigations; and I have therefore determined to bring before you some facts bearing upon this question, which I have been collecting in the hope that other astronomers will likewise publish the results of their observatory experience, and thus by united action assist in the work of tracing these vibrations and changes.

You may remember that in my address to the Society two months since I expressed the hope that the automatic record of the height of the water in Lake George would reveal the effects of some of these terrestrial motions. The instrument used cannot have the extreme sensitiveness to minute vibrations which Darwin's reflecting mirror and other instruments for the like purpose have; but then it is so placed that all such changes become magnified by the relatively enormous extent over which it extends its sensitive part, if I may so express what I mean; for any change in gravity, or the direction of the vertical, is not seen as it affects the base of a small instrument a few feet square, but as it affects a surface 20 miles long and 5 to 6 miles wide. Barometric and wind changes, too, so difficult to see in other instruments, at once become evident here by their effects on such a large body of water,

and the lake gauge for these reasons is not only capable of showing changes quite as minute as the Cambridge pendulum apparatus, but also of keeping a perfectly satisfactory record of these changes, so written that many, if not all, the causes can be traced in the curves which they produce.

Two months since I had not looked for any diurnal effect, and therefore did not see it, although it was clearly marked in almost every sheet that had been taken off up to that time. These curves are small, but there can be no question as to their existence; they are shown as clearly as the larger motions, although, of course, on a small scale. In Europe the pendulum was seen to swing northwards, or away from the equator during the day and towards it at night; and so the water of Lake George runs away from the equator during the day and towards it at night, and this curve can be traced as something added on to all others, (see photoliths of sheets attached), except of course when a strong wind takes entire control of the lake. The diurnal change of level seldom exceeds half an inch, but a tenth of an inch can easily be seen, and this corresponds to a change in the vertical at the lake of 0·016″, an angle so small that even lunar effects may produce double that amount of change; and should any change in the vertical, such as that observed in the carefully conducted observations of M d'Abbadie, namely, 2·4″, it would mean a change of 15 inches, or 150 times as much as can be easily seen in the records at Lake George.

The reference here is to slow changes extending over five or six hours or days, and no such change in the level of the lake has appeared during the four months the gauge has been at work. Nor can I hear that any such changes of level have ever been seen by those who have resided at the lake for years. Small changes of this kind do occur at long intervals, but they are so small that it would seem the earth's surface at the lake is more rigid than it is in Europe; or that some of the observations recorded there do not represent changes in the earth's surface, but in the instruments used. One of these small changes is shown in the photolith of the sheet July 27 to August 3. On July 27th the water in the lake was rough, owing to a northerly wind. About 8 a.m. of 28th the north wind ceased, and the weather became remarkably calm; yet the water fell 5½ inches in two hours, and a series of periodic waves, much larger than those caused by the wind, was set up, and the mean level of the water during all day of 28th was 1½ inch lower than during the 27th. This change in level might be accounted for by the falling of the north wind and the water recovering its normal position, but for the fact that at 9 a.m. on July 29th the water suddenly rose again while the weather was quite calm. I have not drawn the mean line through these waves; its position is so obvious that

that did not seem necessary. A self-recording aneroid works with the lake register to show any variation in barometric pressure, and there is nothing in its record on July 28th to justify this change. The barometer was 0·200 inch below the average from midnight to noon, and during the rest of the day it rose up to the mean. Its changes, therefore, do not accord with those in the lake on that day, and I am unable to offer any solution of the difficulty, except a change in the vertical. The recording machine is fixed on six piles driven into the bed of the lake, and then braced together so as to make the support as firm as possible. No change can take place in the relation of the pencil and the paper except by a change in level of the water, or a change in the length of 6 feet of brass chain connecting the float and the wheel, due to temperature, and any change of this sort would be quite inappreciable. I mention this to show that the change in the level of the water cannot have been due to instrumental changes, and there was no wind to produce it, nor any sufficient change in the barometer to account for it.

The diurnal change can be seen in the photoliths attached on July 30, 31, August 1 and 2, and still more on March 14 and 15. On July 30 and 31 the change is very small, and illustrates very well how small a change in level is made evident by this method of registration. March 14 and 15 also show this curve as superadded on to other curves or waves, and as the observer expressly states that there was no wind on these dates, the curve cannot be due to difference in day and night breezes. The ease with which these diurnal changes can be seen through the other changes due to periodic waves and winds is very suggestive of the best method of recording such complicated phenomena. An observer watching such changes in a level or pendulum would naturally take the observations at intervals, and these photoliths show clearly that he might determine to do it at such intervals, say every half-hour, as would give him a very imperfect representation of what was going on, whereas the continuous record shows clearly all the changes.

On the record for July 28 a good example will be seen of the periodic waves, whose period is about two hours and eleven minutes; the greatest change of level yet recorded in these waves is 13 inches. The first wave of a set is nearly always the largest, and it often happens that a wave is left out, or its period altered by a small or secondary wave. At A, for instance, the interval between the crests is nearly double that of subsequent waves, and at B a small wave seems to cut off the crest of the larger one. These are common features, both in calm and windy weather, and are very perplexing unless they represent changes in the vertical. As I pointed out just now, two hours after the northerly wind ceased on 28th July the water began to fall at the south end of the lake, and fell 5½ inches, when there was not a breath of wind

at the gauge; and to make such a change, a strong southerly gale of wind would be required blowing on the south end of the lake, near where the gauge is, which could not have been the case without the observer knowing it.

There was no jump in the instrumental corrections of the Sydney transit coincident with this lake change on July 28, nor any circumstances of lunar position which might be supposed to be connected with it. Here, for the present, I must leave these lake changes, only remarking that the record referred to above was made subsequent to the reading of this paper, but before the proof was corrected, and I have used it as a better example than that used at the meeting.

Before I leave this part of my subject I would like to call your attention to the fact that the lake is most disturbed when the barometer is low, which accords with the results of seismic observations in Italy and other places. You may remember that in my address, read in May, I expressed the opinion that the greater dis turbance with a low barometer was not because the barometer was low, but because the wind was then more fitful and rapid in its movements, and caused the lake to be similarly affected, and I still hold to that opinion. The question is, I think, yet to be decided whether the relief of pressure on the earth's surface which a low barometer brings is the immediate cause of earthquake phenomena; or whether it is the friction and pressure of the wind on the earth which sets it into vibration in the same way as it does the sea.

The statement made by M. Plantamour that in Europe the eastern piers of transit instruments rise in summer and fall in winter is one of such importance from an astronomical point of view that it should be proved or disproved at once, and I therefore wish to contribute the results of our experience towards the discussion of this question, for it is only by collecting the results from a great number of observatories that this can be properly done. Some sixteen years since, I worked up, for the late Mr. Smalley, all the then existing azimuth observations in Sydney, and four years of Greenwich results, for a paper which he read to this Society on "the azimuthal changes of hills." Ever since I have been very much interested in the question. At the time I refer to, and for some years after, we had at Sydney one of those old-fashioned transit circles with the telescope and circle near one pier; an example of the gradual change by which we got from the old mural circle to the symmetrical modern transit instrument. Ours was made up of cast and hammered brass, in just so many pieces as suited the workman's convenience, and these, put together under the then existing idea of what was best or most convenient to make, resulted in an instrument which, viewed in the light of present practice, seems to have

been designed not to give correct results, but the greatest uncertainty in working. Certainly ours justified such a view, and was most unsatisfactory in every way. However, in the results of azimuth, Mr. Smalley thought he could trace the annual curve which had been found in the Greenwich and two or three other transit instruments, especially Cambridge, and he was convinced that the changes in question were due to the position of the Observatory on a large hill of sandstone rock of which the north and west sides are cut down about 40 feet, exposing bare rock faces to the sun and weather. And it is interesting, now that we have eight years' work by the new transit instrument, to compare the results with the old one. The new instrument has an objective of 6½ inches, was made by Troughton & Simms, special care being taken to secure stability in every way; the piers are each made of cast iron, and are bolted to a block of sandstone 8 feet 6 inches long, 3 feet wide, 18 inches thick, which rests on a mass of masonry 16 feet long, 5 feet wide, and has for foundation the solid sandstone of which the hill is composed. You will see that although the hill is not the place an astronomer would choose to put an observatory, it is yet far more stable than it was supposed to be, in fact it is quite evident that the faults of the old instrument were unjustly laid on the hill. If we could only stop the production of smoke, which seems to me to be increasing in a geometrical ratio, the site would do for many years to come.

The diagram showing the annual variations of the level and azimuth of the new transit instrument will show you that the level goes through a regular annual variation, the eastern pier rising in June to its highest point the same as it does at Greenwich, and at least *some* other European Observatories. The range in our level is a small one, only about 10″, and so regular that the level errors of one year might be taken for the next without serious error.

During the years 1877 to 1881 there was a slight gradual increase of level, probably due to the settling of the pier, which had been in part rebuilt for the new instrument, and a subsequent fall, as will be seen in the following table.

Level errors of the Sydney Transit Instrument :—

	Highest reading. ″	Lowest. ″	Mean. ″
1877	14·0	7·0	10·5
1878	15·5	5·0	10·3
1879	18·5	7·5	13·0
1880	19·5	9·5	14·5
1881	20·0	10·0	15·0
1882	19·0	9·0	14·0
1883	18·0	9·0	13·5
1884	19·0	7·0	13·0
1885	14·7	5·5	10·2

Falling means that the western pier, which is the higher of the two, is getting lower; and, in connection with this, it is interesting to remark that during the past three years men have been at work cutting off irregularities in the cliffs on the western side of the hill and trimming the face to a perpendicular line; a large quantity of stone, amounting to about 5,000 tons weight, has been gradually removed, and one would expect the removal of such a mass of stone to relieve the strata on that side and allow it to rise, whereas the instrument shows a fall on the west side; I think we must, therefore, conclude that no appreciable effect on the instrument has been caused by the removal of the stone. The sandstone of which the hill is composed possesses very decidedly marked stratification in beds which are nearly horizontal, but through these there are vertical joints running in lines about N.N.E., so that the rock which was cut away was separated from the part on which the Observatory stands by several of these joints. There is one other point I wish to draw your attention to in the level curves, viz., the small deviations from the general curve. These are generally supposed to be errors of observation or accidental displacement of the instrument, and in many observatories such deviations are treated as errors, and corrected to the mean line or probable error; but in face of the observed changes in the earth's surface which have been recorded, it is very doubtful if that is the correct way of dealing with what may be due to a variation in the vertical affecting the instrument for some hours only, or during the time the observations were made. I was very much interested by what Mr. Darwin says at the end of his careful examination into the evidence on this point, viz.—"I venture to predict that at some future time practical astronomers will no longer be content to eliminate variations of level merely by taking means of results, but will regard corrections derived from special instruments as necessary to each astronomical observation."

Looking at the curves representing the azimuth, you will see that there is little or no sign of any annual variation. Since the instrument was set up, the azimuth has gradually increased each year at the rate of 5″ per annum for the two first years and 3″ per annum during the four last years. The more rapid change of azimuth during the first years was probably due to the same cause which made the level change, but whether the gradual increase in the azimuth, the instrument turning towards the east, is to go on remains to be seen. I remember when I first joined the Observatory the Rev. Mr. Scott was then watching a progressive change in level of the same character, which went on for many months, and so rapidly that he computed the Observatory would in 260 years, if the rate was maintained, topple over into Darling Harbour. As the whole of the transit instrument foundations had been but recently built, this change was perhaps not surprising, but it ceased in due

time, and I am waiting patiently to see when the easterly excursion of our transit instrument is to cease and the return take place. You will observe in the azimuth curves that there are some considerable deviations from the mean line, but the determination of azimuth cannot be so accurate as the level, because it depends upon the positions of stars which are not all accurately known, and the state of the atmosphere at the time of observation, which may, if bad, introduce errors into the observer's work. The absence of an annual curve in the azimuth is very remarkable when we remember that it is seen at Greenwich and many other Observatories situated on hills. Even here, with the old instrument, it was obvious enough, and one is tempted to ask was it due to the imperfections of the instrument? The new instrument is so reliable in every respect that I feel every confidence in the results it gives, while the old instrument was in every respect faulty, and probably the annual change in temperature caused some change in it in azimuth. The instrument was fitted with a screw adjustment for azimuth, so that when the error became large the screw was used to set it right, and this facility of motion may have been the cause of the annual change in azimuth, the changing in temperature affecting the screw and hence the Y which it moved. Fortunately the new instrument has no means of adjusting in either level or azimuth, and there can be no doubt that any change appearing in the corrections is due to an actual change of position of the whole instrument. I cannot, however, help thinking that perhaps some azimuthal changes in hills are caused by imperfect instruments. In speaking so far of the changes in the axis of the transit, I have given its amount in seconds of arc, but for the convenience of any member who may not be familiar with the size of the instrument, and therefore of the actual linear change which a second of arc represents, I may say that it is $\frac{2}{10000}$ of an inch or 0·0002. This will serve also to give some idea of the delicacy of the instrument; and I may add that a change of a second of arc is always a matter for serious consideration, and sometimes of considerable trouble. These small changes trouble none but astronomers, but, to us, the modern proofs that changes of such amounts are constantly going on in the ground on which all our instruments must rest give rise to many doubts, and show the need for a full investigation of this subject, and it is to be hoped that the laws (if any) of these changes will soon be determined.

Sydney Observatory is situated on a sandstone hill which forms one of the headlands in the harbour, and on the west side, at a distance of 165 feet from the transit instrument, the rock has been cut down 40 feet to a perpendicular face, as mentioned just now, which is to some extent exposed to the afternoon sun, but only for part of the afternoon, as the houses partially

protect it. This rock face must be much warmer in summer than in winter, the extreme range probably being from 40° to 120°, and the difference would make an appreciable expansion of the surface stone, but this would not extend to any considerable depth, for I have earth thermometers in this rock to 19 feet, and the summer sun has scarcely an appreciable effect upon them. We may therefore safely assume that the increased temperature does not affect the western face of the rocks deeper than 20 feet; and this expansion cannot affect the transit instrument, because there are vertical joints in the stone running N. and S., and these would prevent any expansion in the western section affecting the others. I am satisfied, after careful examination of the conditions, that the sun's heat cannot, through this western rock face, affect the transit instrument, but in placing the facts before you it was necessary to mention the local conditions.

The suggestion to have a special instrument for recording all these motions will doubtless give rise to many suggestions how best to do it. The record must be continuous, and, from the minuteness of some of the motions, photography would seem to be the best means of registration, although the expense and trouble of it stand very much in the way of its general adoption. The best form of the recording apparatus seems at first sight to be an iron cone buried in the ground, and carrying a telescope so mounted that it could be rotated to test its own verticality. To have in its focus a minute spot of light, which should be reflected down on to the mercury and thence up again on to a sensitive surface moved by clock-work; but this all means years of preparation, and other years of patient accumulation of results before anything could be done in the way of investigation, and one naturally turns to see if the records already collected contain any useful data.

The ocean freely receives and transmits impulses, and we may find some records of these on the tide sheets. Every one knows how the sea sometimes rises without visible cause, and it is usual to say, and is sometimes truly said, the waves come from a distant gale, but there are some which come from other causes and have distinct characteristics as they record themselves on the tide-gauge. Sometimes a single wave of this kind comes in and often many of them together, and we call them earthquake waves, but fail often to hear of any earthquake to give rise to them. As the discussion must eventually include these waves, I append a list ofthe dates when they have been recorded in Sydney. Some of these, beyond doubt, come from earthquakes. Most of the members present will remember the terrible earthquake at Iquique on the 10th of May, 1877, and the remarkable waves which followed it, and were recorded on our coast and tide-gauges.

The following list of waves recorded on—

May 17, 1873	May 8, 1876	May 15, 1879	May 27, 1882
„ 4, 1874	„ 11, 1877	„ 14, 1880	„ 14, 1883
„ 12, 1875	„ 10, 1878	„ 8, 1881	„ 13, 1884

May 18, 1885

will show you that May never passes without some disturbance in the ocean of the same character as that which we attribute to earthquakes; that is, periodic waves, whose interval is about twenty-five minutes. With the disturbance, which usually comes in the second week in May, we have a great fall in temperature, and hence this date in May is known in Europe as that of the "Ice Saints," and amongst astronomers as one of those when the earth passes through meteor streams. Or let us take another date, the 13th of August, that on which the terrible earthquake of Arequipa took place, in 1868, from which came that enormous sea wave that was still 36 feet high when it got to Hawaii, and, as recorded on our tide-gauge, was the greatest ever known here. Not every August have we earthquakes, but that month always takes the earth through a meteor stream on the 10th, and gives us more or less of disturbance on the tide register. In the diagram attached the barometer curves for that month for the past eighteen years are reproduced. Every curve is marked by great barometric disturbances, very many of them between the 6th and 10th of the month. In 1868, when the greatest disturbances took place, we had a thunder-storm in Sydney on the afternoon of August 16th, and the barograph recorded some waves unlike any which I ever saw before or since. There were five of them between 5·40 p.m. and 7·30 p.m., and the interval between the crests of these waves was twenty-five minutes, which is the same period as the so-called earthquake waves. The greatest marked a change in barometer of 0·045 in., and it took place at 7·30 p.m., just eight hours before the largest wave was recorded on the tide-gauge. On the following night a grand display of meteors was seen off this coast.

It is not my intention to detain you with references to the various periods of wave disturbances that appear year after year in the tide register, but rather to publish the list of dates so that they may be compared with other records, which at present I have no means of doing, for want of such records from other observatories.

Referring to the delicacy of astronomical instruments, it is on record that Sir George Airy said he could see the vibrations in the earth caused by children running round the Observatory as he looked into the quicksilver, and see the passage of a train a mile off. I have myself often seen the mercury start suddenly into vibration, and then shortly after I would hear the sound of wheels in the streets near the Observatory, and I had to wait till they were past before I could go on with the observations. Vehicles

travelling fast, such as carriages and cabs, produced far more decided effects than carts. The only good method of avoiding these was to wait till the city had gone to bed.

These and many other facts show us that there can no longer be any question about the condition of the earth taken as a whole. It acts under all the forces affecting it as an elastic ball, yielding inwards to increased atmospheric pressure and rising up when that is removed, and vibrating readily under volcanic or other impulses. The effect of a fall of 1 inch in the barometer, or rather in the pressure of the atmosphere, is, however, no small change; it is equal to lifting one million of tons weight from each square mile of country.

You will remember that I quoted just now M. Plantamour's statement that the eastern piers of the transit instruments in Europe rise during the summer; and, by reference to the curves, you will see that in our winter (that is European summer) the eastern pier of the Sydney transit also rises. If, then, several observatories in the northern hemisphere taken at random and one in the southern hemisphere all find the eastern pier of their transit instruments rising up at the same time of year, the presumption that it affects all transit instruments is very strong; but then comes the question, why is it so? It seems hardly worth while to discuss the probability of its being due to temperature, for if an increase of temperature be the cause of it in the north a decrease of temperature can hardly be the cause in the southern hemisphere.

It is evidently something affecting both hemispheres of the earth at the same time of year in the same way. Such at least is the state of the case as far as the evidence goes. When observatories generally have published the particulars of their transit instrument corrections we shall be in a better position to form an opinion.

Meanwhile, it should be borne in mind that the maxima and minima of the curves coincide with the summer and winter solstices, and that at these times the sun's attraction has the greatest effect upon the equatorial protuberance of the earth, producing a deflection in the direction of the earth's axis, or in other words, a great strain upon the surface generally, and hence possibly a change sufficient to be noted in the corrections of a transit instrument.

The published information is, however, too meagre to justify any further speculation in this direction at present; but if it be true that the moon can produce a diurnal strain sufficient to affect our instruments, then it is quite reasonable to suppose that the sun may annually produce a strain.

In the following diagrams will be found photo-lithographic copies of two sheets from the recording instrument at Lake George; Sydney level curves, 1877 to 1885 inclusive; level curves at Greenwich, 1880 and 1881, for comparison; temperature curves at Sydney, 1882, '83, and '84; also the azimuth curves at Sydney, 1878 to 1885 inclusive; also August barometer curves, 1867 to 1884 inclusive.

LIST of Disturbances in the Water, recorded by the Sydney Tide-gauge.

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1872	Feb. 25	11 to 12 p.m.	½ inch	Very slight.
	Mar. 29	5 p.m.	1 ,,	
	April 2	4 to 5 p.m.	1 ,,	
	June 29	7 to 9 p.m.	1 ,,	
	July 15	11 to 12 p.m.	½ ,,	Very slight.
	,, 24	8 to 10 p.m.	¼ ,,	do
	Aug. 11	1 to 3 p.m.	½ ,,	do
	,, 22	2 to 3 p.m.	½ ,,	do
	Oct. 3	11·30 p.m.	1 ,,	
	,, 29	3 to 5 p.m.	1 ,,	
	Nov. 24	8 to 9 p.m.	1 ,,	
	,, 28	7 to 9 p.m.	¼ ,,	
	Dec. 3	10 to 11 p.m.	½ ,,	
	,, 15	5 to 7 p.m.	½ ,,	
	,, 22	2 to 4 p.m.	¼ ,,	
	,, 30	7 a.m.	½ ,,	
1873	Jan. 12	1 a.m.	1 ,,	
	Feb. 28	2 to 3 p.m.	5 inches	Only one wave.
	Mar. 10	12 to 2 p.m.	1 inch	
	,, 26	9 p.m.	¼ ,,	Very slight.
	April 30	2 to 3 p.m.	½ ,,	do
	May 17	2 p.m.	¼ ,,	do
	June 4	9 a.m.	....	Agitated.
	to ,, 6	7 a.m.	6 inches	Between 6 and 7 p.m. on 5th.
	,, 15	Level of the sea rose 6 to 7 a.m., 4 inches.	....	Heavy rain.

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1873	July 4	9 to 10 p.m.	1 inch	
	,, 25	Level of sea rose 3 in. 3 to 4 p.m.		0·350 in. rain fell in 9 minutes.
	Aug. 2	5 p.m.	¼ inch	
	,, 7	5 to 6 a.m.	½ ,,	
	Sept. 20	4 to 5 a.m.	½ ,,	
	Oct. 30	7·12 p.m.	1 ,,	
	,, 31	All day	2 to 3 inches	Well marked waves.
	Nov. 1	8 a.m.	2 inches	
	,, 9	9 p.m.	1 to 3 in.	
	,, 10	8 p.m.	1 to 2 inches	
	,, 11	All day	1 to 4 ,,	4 inch wave, 1·20 p.m., 11th.
	,, 12	3·30 p.m.	1 to 2 ,,	
	Dec. 17	10 to 11 a.m.	1 inch	
	,, 18	4 to 5 p.m.	½ ,,	
	,, 19	5 to 7 p.m.	¼ ,,	
	,, 25	3 to 4 p.m.	½ ,,	
1874	Jan. 25	4 to 6 p.m.	½ ,,	
	Feb. 10	10 to 12 p.m.	½ ,,	
	,, 22	8 to 9 p.m.	¼ ,,	
	,, 25	8 to 10 p.m.	¼ ,,	
	Mar. 14	9 p.m.	½ ,,	
	April 4	7 to 9 a.m.	½ ,,	
	May 4	3 to 5 a.m.	½ ,,	
	,, 24	3 p.m.	½ ,,	
	June 21	11 to 12 p.m.	½ ,,	
	,, 23	5 to 6 p.m.	½ ,,	
	July 4	3 to 4 p.m.	½ ,,	
	,, 10	2 to 3 a.m.	½ ,,	
	,, 20	7 to 8 p.m.	½ ,,	

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1874	July	30	11 to 12 p.m.	$\frac{1}{4}$ inch	
	,,	31	9 to 11 a.m.	....	
	Aug.	23 to 25	9 a.m., all day ... 12 p.m., all day	1 inch ... 1 to 3 inches	Remarkable waves all the time at Sydney and Newcastle, greatest at Sydney, 3 inch, 10 a.m., 24th.
	,,	27	5 to 6 a.m.	$\frac{1}{2}$ inch	
	,,	30	8 to 9 p.m.	$\frac{1}{2}$,,	
	Sept.	6	1·30 p.m.	$\frac{1}{2}$,,	
	,,	7	10 to 11 a.m.	1 ,,	
	,,	20	1 a.m.	....	
	,,	21	4 p.m.	....	
	Oct.	16	1 to 3 a.m.	$\frac{1}{2}$ inch	
	,,	21	1 a.m.	1 ,,	
	Nov.	2	4 to 6 a.m.	$\frac{1}{2}$,,	
	,,	6	10 a.m.	$\frac{1}{4}$,,	
	,,	9	2 to 3 a.m.	$\frac{1}{2}$,,	
	,,	14	2·30 p.m.	$\frac{1}{2}$,,	
	,,	20	4 a.m.	....	
	,,	25	9 a.m.	....	
	,,	27	1 to 2 a.m.	$\frac{1}{4}$ inch	
	Dec.	10	11 to 12 p.m.	$\frac{1}{2}$,,	
	,,	18	11 a.m.	$\frac{1}{2}$,,	
	,,	23	6 p.m.	$\frac{1}{2}$,,	
	,,	24	9 to 10 a.m.	1 inch	
	,,	29	10 to 11 p.m.	$\frac{1}{2}$,,	
	,,	30	4 to 6 p.m.	$\frac{1}{2}$,,	Very slight.
1875	Jan.	7	6·30 p.m. to 10 a.m. on the 8th...	Over 3 inches each.	Much disturbed; several waves; high tide.
	,,	8	6·30 p.m. to 11 p.m.	....	Disturbed.

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1873	July	4	9 to 10 p.m.	1 inch	
	,,	25	Level of sea rose 3 in. 3 to 4 p.m.	....	0·350 in. rain fell in 9 minutes.
	Aug.	2	5 p.m.	¼ inch	
	,,	7	5 to 6 a.m.	½ ,,	
	Sept.	20	4 to 5 a.m.	½ ,,	
	Oct.	30	7·12 p.m.	1 ,,	Well marked waves.
	,,	31	All day	2 to 3 inches	
	Nov.	1	8 a.m.	2 inches	
	,,	9	9 p.m.	1 to 3 in.	
	,,	10	8 p.m.	1 to 2 inches	4 inch wave, 1·20 p.m., 11th.
	,,	11	All day	1 to 4 ,,	
	,,	12	3·30 p.m.	1 to 2 ,,	
	Dec.	17	10 to 11 a.m.	1 inch	
	,,	18	4 to 5 p.m.	⅓ ,,	
	,,	19	5 to 7 p.m.	¼ ,,	
	,,	25	3 to 4 p.m.	½ ,,	
1874	Jan.	25	4 to 6 p.m.	½ ,,	
	Feb.	10	10 to 12 p.m.	½ ,,	
	,,	22	8 to 9 p.m.	¼ ,,	
	,,	25	8 to 10 p.m.	¼ ,,	
	Mar.	14	9 p.m.	½ ,,	
	April	4	7 to 9 a.m.	½ ,,	
	May	4	3 to 5 a.m.	½ ,,	
	,,	24	3 p.m.	½ ,,	
	June	21	11 to 12 p.m.	½ ,,	
	,,	23	5 to 6 p.m.	½ ,,	
	July	4	3 to 4 p.m.	½ ,,	
	,,	10	2 to 3 a.m.	½ ,,	
	,,	20	7 to 8 p.m.	½ ,,	

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1874	July	30	11 to 12 p.m.	¼ inch	
	,,	31	9 to 11 a.m.	....	
	Aug.	23	9 a.m., all day	1 inch	Remarkable waves all the time at Sydney and Newcastle, greatest at Sydney, 3 inch, 10 a.m., 24th.
		to			
	,,	25	12 p.m., all day	1 to 3 inches	
	,,	27	5 to 6 a.m.	½ inch	
	,,	30	8 to 9 p.m.	½ ,,	
	Sept.	6	1·30 p.m.	½ ,,	
	,,	7	10 to 11 a.m.	1 ,,	
	,,	20	1 a.m.	....	
	,,	21	4 p.m.	....	
	Oct.	16	1 to 3 a.m.	½ inch	
	,,	21	1 a.m.	1 ,,	
	Nov.	2	4 to 6 a.m.	½ ,,	
	,,	6	10 a.m.	¼ ,,	
	,,	9	2 to 3 a.m.	½ ,,	
	,,	14	2·30 p.m.	½ ,,	
	,,	20	4 a.m.	....	
	,,	25	9 a.m.	....	
	,,	27	1 to 2 a.m.	¼ inch	
	Dec.	10	11 to 12 p.m.	½ ,,	
	,,	18	11 a.m.	½ ,,	
	,,	23	6 p.m.	½ ,,	
	,,	24	9 to 10 a.m.	1 inch	
	,,	29	10 to 11 p.m.	½ ,,	
	,,	30	4 to 6 p.m.	½ ,,	Very slight.
1875	Jan.	7	6·30 p.m. to 10 a.m. on the 8th	Over 3 inches each.	Much disturbed; several waves; high tide.
	,,	8	6·30 p.m. to 11 p.m.	....	Disturbed.

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1875	Jan. 31	5 p.m. to 5 a.m. 1 Feb.	Over 1 inch.	Disturbed, especially at low tide; several waves.
	Feb. 4			High tides; disturbed.
	„ 5			
	„ 10	4·30 p.m.	2 inches	One separate wave at low tide; distinctly marked.
	„ 17	4·30 p.m. to 8 p.m.		High tide; disturbed.
	„ 26	11·45 p.m. to 10 p.m. March 1		All the tides *continuously* disturbed.
	Mar. 14	10 to 3·30 a.m., 15th		Slightly disturbed.
	„ 16	3 p.m. to 6 a.m., 17th		do do
	„ 29	10·15 a.m. to 9·15 p.m.		High and low tide; much disturbed.
	„ 29	11·15 to 6 a.m. April 2		All the tides disturbed.
	April 8	4·15 p.m.	$2\frac{1}{2}$ inches	One solitary wave; low tide; very marked.
	„ 11	2·15 p.m. to 12·30 p.m., 15th		Slightly disturbed.
	„ 21	4·30 p.m.	$1\frac{1}{2}$ inch	One wave; low tide.
	„ 25	7·30 a.m. to 6 p.m.		High and low tide; disturbed.
	„ 26	7·15 a.m. to 9 p.m., 28th		All the tides disturbed.
	May 2	10·45 p.m.	$1\frac{1}{2}$ inch	One separate, clearly defined wave; low tide.
	„ 2	1·45 p.m. to 6 a.m., 3rd		Disturbed.
	„ 3	10·15 a.m.	1 inch	One wave; low tide.
	„ 11	6·30 p.m.	1 „	do do
	„ 12	10 a.m. to 4 a.m., 13th		Much disturbed.
	„ 13	1·30 p.m. to 4 a.m., 14th		do
	„ 14	4 p.m. to 5·30 a.m., 15th		do
	„ 15			Slightly disturbed.
	„ 16			
	„ 25	3·30 p.m. to 12·15 a.m. 26th		Slightly disturbed.
	„ 26	10·30 a.m. to 8 p.m.		Much disturbed.

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1875	May	27	11·45 a.m. to 2·45 a.m. on the 28th		Disturbed.
	,,	28			Slightly disturbed.
	,,	29			
	June	6	4 a.m. to 6·30 a.m.		Low tide, disturbed.
	,,	10	6·30 p.m.	1 inch	One wave — Low tide; disturbed.
	,,	10	7·45 p.m.	1 ,,	do
	,,	11	2·30 p.m. to 6 a.m. on the 13th		Disturbed.
	,,	14 to 16			do
	,,	24	9 a.m. to 1 a.m. on the 25th		Slightly disturbed.
	,,	27	9 a.m. to 4·30 a.m. on the 28th		Disturbed.
	,,	28 to 30			Slightly disturbed.
	July	9 to 11			Disturbed.
	,,	12			Much disturbed.
	,,	13		2 inch	One wave; much disturbed.
	,,	14			Disturbed.
	,,	17			do
	,,	28	11 p.m. to 1·30 a.m. on the 29th		do
	Aug.	9	7·30 a.m.	1 inch	One wave.
	,,	22	7·30 p.m. to 8 a.m. on the 23rd		Disturbed.
	,,	23			Much disturbed.
	,,	24		1½ inch	One wave.
	,,	31	4·45 p.m.	2 ,,	do
	,,	31	5·15 p.m.	2 ,,	do
	Sept.	8			Disturbed.
	,,	9 and 10		2 inches each.	Several waves; very much disturbed.
	,,	21	9·30 p.m. to 6 p.m. on the 22nd.		Disturbed.
	Oct.	3	9 a.m. to 2 a.m. on the 4th		do
	,,	5	4 a.m.	2½ inches	One wave; low tide; disturbed.
	,,	7	6·30 a.m.	1 ,,	One wave, low tide.

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1875	Oct.	7	6·30 a.m. to 9 a.m. on the 9th		Disturbed.
	,,	19	10 p.m. to 9 a.m. on the 20th		do
	,,	21	8·30 p.m. to 9 a.m. on the 22nd		High and low tides ; much disturbed.
	,,	31	4·30 p.m. to 12·30 a.m. on 1st Nov.	5 inches	Very much disturbed.
	Nov.	1	9 p.m. to 7·30 a.m. on the 2nd		Disturbed.
	,,	2	9 p.m. to 7 a.m. on the 3rd		do especially low tide.
	,,	3, 4, and 5			do
	,,	6 and 7			Much disturbed.
	,,	20	11·30 p.m. to 7 p.m. on the 21st		Disturbed.
	,,	29	6 p.m. to 11·30 p.m.	3 inches each.	Several waves, high tide.
	,,	30	6·15 p.m. to 6·30 a.m. on 1st Dec.		Much disturbed.
				2 ,,	Two waves, high tide ; one wave, low tide.
	Dec.	1	7 p.m. to 2·30 a.m. on the 2nd		Disturbed.
	Note.—From Nov. 29 to Dec. 3 (with the exception of 30th Nov.) the high tides disturbed and the low tides steady.				
	Dec.	5	12·30 a.m. to 8 a.m.		Disturbed.
	,,	5	7 a.m.	1 inch	One wave, low tide.
	,,	6	12·30 a.m. to 8·30 a.m.	$1\frac{1}{2}$ & 2 inches.	Much disturbed, especially low tide.
	Note.—From the 5th to the 8th the whole of the tides disturbed.				
	Dec.	24	2 p.m. to 9 a.m. on the 25th	3 inches each.	Much disturbed, both high and low tides.
	,,	31	3·30 a.m. to 11·30 a.m.		Slightly disturbed.
1876	Jan.	5	5 a.m.	$\frac{1}{2}$ inch	
	,,	12			Violent agitation at high tide till 12 p.m.
	,,	13		$\frac{1}{4}$ inch	
	,,	19	About 2 p.m.	$1\frac{1}{4}$,,	Tidal disturbance.
	,,	20	7 to 9 p.m.	$\frac{1}{2}$,,	
	,,	21	10 to 11 p.m.	$\frac{1}{2}$,,	
	Feb.	10	6 to 7 p.m.	$\frac{1}{3}$,,	

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1876	Feb. 16	8 p.m.	....	Agitations all the time, especially at high tide.
	to			
	„ 19	12 p.m.	....	
	„ 21	8 to 9 p.m.	½ inch	
	„ 27	2·30 p.m.	....	Rise in tide of 4 inches, probably due to rain; rain, 0·523 inch.
	Mar. 18	9 a.m. to 6·30 p.m.	....	Violent agitation.
	„ 23	10 to 11 p.m.	⅛ inch	
	April 8	9 to 10 p.m.	½ „	Very slight.
	May 3	11 p.m.	....	Rise in tide 3¼ inches, probably due to rain; rain, 2·416.
	„ 5	11·30 p.m.	....	Rise in tide ⅜ inch, probably due to rain; rain, 0·889.
	„ 7	1 to 2 a.m.	....	Rise in tide 1½ inch, probably due to rain; rain, 2·238.
	„ 8	From 6 a.m. till 3 p.m.	....	Violent agitation.
	„ 11	4·30 p.m.	½ inch	
	„ 13	3 to 4 a.m.	½ „	Violent agitation at high tide.
	„ 21	12 p.m.	....	Rise in tide of 3 inches, probably due to rain; rain, 2·815.
	June 6	6·30 p.m.	½ inch	Very slight.
	„ 6	11 a.m.	¼ „	do
	„ 11	6 p.m.	¼ „	do
	„ 13	12·30 a.m. to 8 p.m.	....	Violent agitation.
	„ 15	1 p.m.	....	
	to			
	„ 18	9 a.m.	....	Violent agitation.
	„ 21	4·30 a.m.	½ inch	

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1876	June 22	12 a.m.	$\frac{1}{2}$ inch	Tide, 7 feet 7 inches; water came over Erskine-street Wharf.
	,, 27	5·30 a.m.		Rise in tide $1\frac{1}{2}$ inch.
	July 15	9 a.m.		Violent agitation.
	to			
	,, 16	9 a.m.		
	Aug. 1	4 to 6 p.m.	$\frac{3}{4}$ inch	
	,, 5	8 to 9 p.m.	$1\frac{1}{4}$,,	
	,, 7	7 a.m. and p.m.	$\frac{3}{4}$,,	
	,, 23 & 24			Slight.
	,, 24	Midnight	$1\frac{1}{2}$ inch	
	,, 28 to 29			Slight.
	,, 29 to 30		1 inch	
	Sept. 9	10 to 11 p.m.	$\frac{1}{3}$,,	
	,, 10	2 to 3 a.m.	$\frac{1}{2}$,,	Very slight.
	,, 10	10 p.m.		Violent agitation.
	to			
	,, 12	5·30 p.m.		
	,, 14	1·30 p.m.	$\frac{1}{3}$ inch	
	,, 16	4 p.m.	1 ,,	Well marked intervals.
	,, 26	12·30 p.m.	$\frac{1}{2}$,,	
	Oct. 24	2 to 4 a.m.	$\frac{1}{4}$,,	
	,, 24	10 p.m.		Violent agitation.
	to			
	,, 28	3 p.m.		
	,, 29	3 p.m.	$\frac{1}{3}$ inch	
	Nov. 4	11·30 a.m.	$\frac{1}{4}$,,	
	,, 5	1·30 p.m.	$\frac{1}{4}$,,	
	,, 10	12 to 1 p.m.	$\frac{1}{2}$,,	

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1876	Nov. 11	2 to 3 a.m	$\frac{1}{2}$ inch	
	,, 11	12 to 1 p.m.	$\frac{1}{2}$,, ...	
	,, 16	....	....	Rise in tide 7 inches, probably due to rain, 2·108 inches.
	,, 20	2 a.m.	....	Violent agitation.
	,, 20	12 noon	....	
	,, 24	12·30 p.m.	....	do
	,, 25	10 p.m.	....	
	Dec. 16	7 p.m.	....	do
	,, 17	11 a.m.	....	
1877	Jan. 8	12·30 p.m.	1 inch	
	,, 9	8·30 p.m.	$\frac{1}{2}$,, ...	
	Feb. 22	11 p.m.	$\frac{1}{2}$,, ...	
	Mar. 17	1 a.m.	$\frac{1}{4}$,, ...	
	April 30	8 p.m.	$\frac{1}{2}$,, ...	
	May 2	....	....	Violent agitation all day.
	,, 11 .... to	From 5·20 a.m.	....	Earthquake waves 3 feet 6 inches in Sydney; 2 feet 3 inches at Newcastle (greatest waves).
	,, 15	12 a.m.	....	Iquque (in Peru) destroyed.
	,, 20	6 to 8 p.m.	$\frac{1}{2}$ inch	
	,, 23	7 to 8 p.m.	$\frac{1}{2}$,, ...	
	July 12	12 to 2 p.m.	1 ,, ...	
	,, 14	....	....	Rise of tide 6 inches, probably due to rain, 1·538 inches.
	,, 14 .... to	10·30 p.m.	....	Violent agitation.
	,, 15	5 p.m.	....	
	,, 15	6 p.m.	....	Rise in tide 4 inches, probably due to rain, 3·109 inches.

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1877	Aug.	4 to 5	....	....	Slight.
	,,	5 to 6	....	1 inch	
	,,	14 to 15	....	1 ,,	
	,,	16 to 17	....	½ ,,	
	,,	23 to 24	....	1 ,,	
	,,	25	4 p.m.	½ ,,	
	Sept.	20	1 to 2 p.m.	....	Rise in tide 3½ inches, probably due to rain, 0·449 inches.
	Oct.	4	11 to 12 p.m.	....	Rise in tide 3½ inches, probably due to rain, 4·890 inches.
	,,	14	5 to 7 p.m.	½ inch	
	,,	19	4 a.m.	½ ,,	
	,,	27	8 to 9 p.m.	1 ,,	
	Nov.	10	2 a.m.	½ ,,	
	,,	16	....	3½ inches	Violent agitation all day.
	,,	21	....	4 ,,	Rise in tide of 6 inches (and agitation), probably due to rain, 0·280, on 18th; 1·088 on 19th; 0·352; and 20th, 0·309.
	,,	27	11 p.m. to 5 a.m. (28th)	4 inches	Violent agitation.
	,,	28	4 p.m.	1 inch	
	Dec.	9	9 to 10 p.m.	½ ,,	
	,,	18	10 p.m.	½ ,,	
1878	Feb.	11	....	....	Agitation all day.
	,,	15	....	....	Rise in tide of 2 inches, probably due to rain, Rain, 2·265.
	April	26	2 to 4 p.m.	½ inch	
	,,	28	....	....	Agitation all day.
	,,	29	9 to 10 p.m.	½ inch	

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1878	May 10 to May 13	10 a.m. All day	2 inches	Slight, except one of 2 inches at 3 p.m. Slight.
	June 3	3 to 5 a.m.	1 inch	
	July 26	9 to 10 p.m.	½ ,,	
	Aug. 12	5 to 7 p.m.	½ ,,	
	,, 14	5 to 6 p.m.	½ ,,	
	,, 19 to 20		1½ ,,	
	,, 21 to 22	All day	½ ,,	
	,, 22 to 23	,,	1 ,,	
	,, 23 to 24	,,	1 ,,	
	,, 29		¾ ,,	Rising tide.
	Sept. 25	4 to 6 a.m.	½ ,,	
	,, 26	5 to 7 a.m.	¼ ,,	Very slight.
	,, 27	4 to 6 p.m.	½ ,,	
	Oct. 10	5 to 6 p.m.	½ ,,	
	,, 18	5 to 7 a.m.	½ ,,	
	Nov. 4	6 to 8 p.m.	½ ,,	
	,, 21	2·30 a.m.	½ ,,	
	Dec. 22	9·30 p.m.	1 ,,	
	,, 28	1.30 p.m.	½ ,,	
	,, 29	4 to 6 p.m.	¼ ,,	Very slight.
1879	Jan. 2 to 3			
	,, 22 to 23			
	,, 31 to Feb. 1			
	Feb. 1 to 2			
	,, 9 to 10			
	,, 15 to 16			
	,, 16 to 17			

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1879	Mar.	15 to 16			
	May	9 to 10			
	,,	15 to 16			
	,,	27 to 28			
	,,	28 to 29			
	July	24 to 25			
	Aug.	4 to 5		1 inch	
	,,	7 to 8		2½ inches	
	,,	8 to 11		½ inch	
	,,	13	All day	1¼ ,,	
	,,	17	,,	1 ,,	
	,,	24 to 25	,,	1 ,,	
	,,	28 to 29			
	Nov.	19 to 20			
	Dec.	19 to 20			
	,,	21 to 22			
	,,	22 to 23	Very marked all forenoon		
	,,	23 to 24			
	,,	27 to 28			
	,,	28 to 29			
1880	April	2	4 to 7 p.m.	½ ,,	Very slight.
	,,	13	12 to 3 p.m.	¼ ,,	do
	,,	17	5 p.m.	¼ ,,	One wave.
	May	8	6·30 p.m.	1 ,,	do
	,,	14	6·40 p.m.	1 ,,	do
	,,	16	11 p.m.	¼ ,,	Very slight.
	,,	29	4 to 6 p.m.	½ ,,	One wave.
	June	15	4 to 6 p.m.	½ ,,	Very slight.
	July	4	1·30 p.m.	½ ,,	One wave.

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1880	July 28	5 to 7 p.m.	½ ,,	One wave.
	From Sept. 24 to Sept. 28	From 10·40 a.m. to morning of 28th	3 inches	Earthquake in Chili; first wave here 10·40 a.m. (24th).
	Nov. 8	2 to 4 p.m.	½ inch	Very slight.
	,, 23	5·30 a.m.	½ ,,	do
	Dec. 31	10·30 p.m.	¼ ,,	do
1881	Jan. 2	6 to 7 p.m.	½ ,,	One wave.
	,, 16	6 to 7 a.m.	¼ ,,	Very slight.
	,, 18	6 to 8 a.m.	½ ,,	do
	,, 19	6 to 8 p.m.	¼ ,,	do
	,, 20	8 p.m.	½ ,,	do
	,, 30	5 to 7 p.m.	½ ,,	do
	Feb. 4 to ,, 8	7 a.m. to 10 a.m.		
	,, 24	12 p.m.	½ inch	Very slight.
	March 9 to ,, 12	10·30 a.m. to 6·30 a.m.		
	April 4 to ,, 10	11·30 a.m. to 6 to 7 p.m.		
	,, 23	5 to 7 p.m.	½ inch	Very slight.
	May 5	10 to 11 p.m.	½ ,,	do
	,, 6	5 to 7 p.m.	¼ ,,	do
	,, 8	8 p.m.	½ ,,	do
	,, 30	11 to 12 p.m.	½ ,,	do

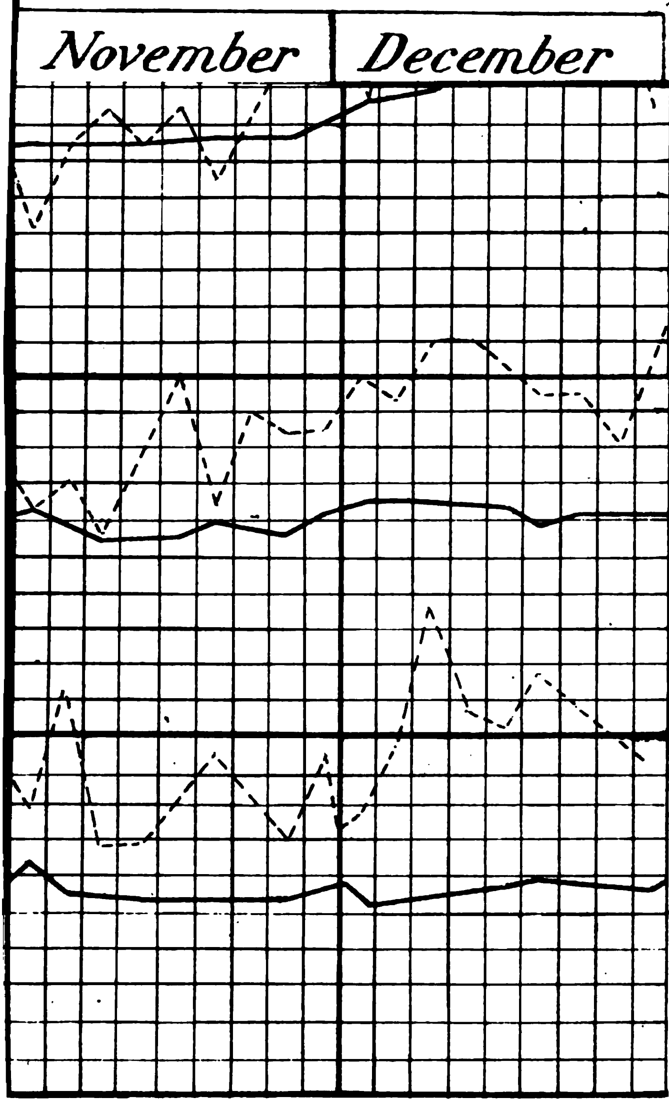
Year	Month and Day.		Hour.	Amount of Motion.	Remarks.
1881	June	2	7·30 p.m.	¼ inch	Very slight.
	,,	3	9·30 p.m.		
	to				
	,,	6	9 a.m.		
	,,	9	10 to 12 p.m.	½ inch	Very slight.
	July	3	6 to 8 p.m.	½ to 2½ inch.	
	Aug.	22	5 p.m.	¾ ,,	
	to				
	,,	23	3·30 p.m.	1 ,,	
	Sept.	21	4 to 5 p.m.	½ ,,	Very slight.
	,,	22	10·30 p.m.		
	to				
	,,	24	1 p.m.		
	Oct.	2	5 to 8 p.m.	¼ inch	Very slight.
	,,	11	1 p.m.	½ ,,	do
	,,	12			
	,,	14	11 to 1 p.m.	¼ inch	Very slight.
	,,	16	5 to 6 p.m.	½ ,,	do
	,,	17	3 p.m.		
	to				
	,,	19	1 a.m.		
	Dec.	12	4 to 7	½ inch	Very slight.
	,,	16	10 p.m.		
	to				
	,,	18	9 a.m.		
	,,	18	7 to 9 p.m.	½ inch	Very slight.
	,,	19	4.30 p.m.	¼ ,,	do
	,,	27	7 a.m.		
	to				
	,,	31	9 a.m.		

Year.	Month and Day.	Hour.	Amount of Motion.	Remarks.
1882	Jan. 10	....	1 inch	Very slight.
	„ 12	11 p.m. to 1 a.m.	½ „	do
	„ 21	7 to 9 p.m.	½ „	do
	„ 30	12·30	½ „	do
	to			
	„ 31	9 a.m.	½ inch	do
	Feb. 8	1 to 3 p.m.	½ „	do
	„ 19	9 to 11 p.m.	½ „	
	Mar. 28	8 to 10 p.m.	½ „	Very slight.
	April 5	....	½ „	Level of the water raised 7½ inches by the rain; began 3·30 p.m. to 8 p.m. in 5½ hours 6·482 in. fell.
	„ 20	6 to 8 a.m.	½ „	
	„ 21	2 to 3 a.m.	½ „	
	„ 26	9 to 11 p.m.	½ „	
	May 27	6 to 8 a.m.	1 „	
	June 8	7 to 9 p.m.	¼ „	
	July 2	7 to 9 p.m.	½ „	
	„ 26	1 to 3 a.m.	1 „	
	Aug. 3	8 to 9 a.m.	½ „	
	„ 12	2 to 4 a.m.	½ „	
	„ 22 to 23	....	1 „	One jump in the falling tide.
	Sept. 7	7 to 9 p.m.	½ „	
	„ 16	4 to 6 p.m.	½ „	
	„ 19	4 to 5 p.m.	½ „	
	Oct. 2	2 a.m.	....	
	to			
	„ 3	2 a.m.	....	
	„ 4	5·30 a.m.	½ „	
	„ 23	2 to 4 p.m.	½ „	
	„ 26	12·30 p.m.	½ „	

Year	Month and Day.	Hour.	Amount of Motion.	Remarks.
1882	Dec. 7	4 to 5 a.m.	$\frac{1}{4}$ inch	
	,, 18	5 to 6 p.m.	$\frac{1}{2}$,, ...	
	,, 19	7 to 9 a.m.	$\frac{1}{2}$,, ...	
	,, 20	7·30 p.m.	$\frac{1}{2}$,, ...	
	,, 27	6 a.m.	$\frac{1}{2}$,, ...	
1883	Jan. 15	3 to 4 p.m.	$\frac{1}{4}$,, ...	
	Feb. 2	5 to 7 p.m.	1 ,, ...	
	,, 9	11·30 p.m.	$\frac{1}{2}$,, ...	
	,, 19	3 a.m.	$\frac{1}{2}$,, ...	
	Mar. 17	6 to 8 p.m.	$\frac{1}{4}$,, ...	Very slight.
	May 14	7·30 p.m.	$\frac{1}{4}$,, ...	
	June 12	3 to 5 p.m.	$\frac{1}{2}$,, ...	
	July 13	3 to 5 a.m.	$\frac{1}{2}$,, ...	
	,, 27	11 p.m. to 1 a.m. on the 28th	$\frac{1}{2}$,, ...	
	Aug. 11	9·30 a.m.	....	
	,, 13	9·0 a.m.	....	
	,, 30	2 to 4 p.m.	1 inch	
	,, 30	8 to 10 p.m.	$\frac{1}{2}$,, ...	
	,, 31	10 to 12 p.m.	$\frac{1}{2}$,, ...	Barometer much disturbed by Krapatoa eruption.
	Sept. 13	12·30 p.m.	$\frac{1}{4}$,, ...	
	,, 19	11 to 1 p.m.	$\frac{1}{2}$,, ...	
	,, 24	5 to 6 p.m.	$\frac{1}{2}$,, ...	
	,, 27	1 p.m.	3 ,, ...	
	,, to 29	7 a.m.	2 ,, ...	
	Oct. 9	3 to 5 p.m.	$\frac{1}{4}$,, ...	
	Nov. 15	10 to 12 p.m.	$\frac{1}{2}$,, ...	
	Dec. 1	11 to 12 p.m.	$\frac{1}{4}$,, ...	
	,, 8	11 to 1 am.	$\frac{1}{2}$,, ...	
	,, 16	3 p.m.	1 ,, ...	
	,, 19	3 to 4 p.m.	$\frac{1}{2}$,, ...	

Year.	Month and Day.		Hour.	Amount of Motion.	Remarks.
1883	Dec.	23	10 to 12 p.m.	½ inch	
1884	Jan.	17	9 p.m to 4 a.m. on the 18th	....	Disturbed.
	„	28	10·30 p.m.	1 inch	One wave.
	April	5	8·45 p.m. to 1·30 a.m. on the 6th	....	Much disturbed.
	„	6	10 p.m. to 2 a.m. on the 7th	1½ inch	One wave.
	May	13	10·30 p.m.	1 „	Not remarkable.
	„	16	1 a.m.	1 „	
	„	17	0·30 p.m.	1 „	
	July	1 to 4	....	3 „	One wave; disturbed.
	Aug.	26	10 p.m.	½ „	One wave.
	Sept.	1 to 2	....	....	Disturbed.
	Oct.	6	8 a.m.	2 inch	One wave.
	„	6	8 p.m. to 9 a.m. on the 7th	2 „	...... high tide.
	„	8	9·40 p.m. to 1 a.m. on the 9th	4 „	do
	„	21	7·30 p.m. to 12 midnight	3½ „	One wave, do
	Nov.	16 to 17	6 p.m. to 3 a.m. on the 17th	up to 7 inches.	At Newcastle.
1885	Jan.	9	7 p.m.	¼ „	Very slight.
	„	17	10·30 p.m.	1 „	do
	Feb.	1	10 to 11 a.m.	1½ „	do
	„	13	11 to 12 a.m.	½ „	do
	„	23	....	....	
	„	28	4 p.m.	½ inch	do
	April	7	3 to 4 p.m.	½ „	do
	May	7	5 p.m.	½ „	do
	„	8	5·30 a.m.	¼ „	do
	„	22	4·30 a.m.	¼ „	do
	June	6	5·30 p.m.	¼ „	
	„	9	11 to 1 p.m.	½ „	do
	„	18	4 to 6 p.m.	„	do
	„	26	2 to 4 p.m.	¼ „	do

[Five diagrams.]



aper on Local Variations and Vibrations.

Some causes of the decay of the Australian Forests.

By the Rev. Peter MacPherson, M.A.

[*Read before the Royal Society of N.S. W., 5 August, 1885.*]

The traveller by train from Geelong in Victoria to Ballaarat passes through a great extent of forest. In the year 1874 he would notice a large number of the tall white skeletons of trees which had been growing luxuriantly on the banks of Bruce's Creek, the "Muddy Waterholes" of the early days of the Colony. Approaching Meredith the character of the forest changes, the prevailing species of tree being much smaller. A little distance beyond Meredith, in a space bounded by two shallow valleys, large numbers of trees were to be seen dying and dead in the year already specified. The progress of decay the writer watched for twelve years, 1862–74. It had advanced for some miles from the Woodbourne and Cargerie Creeks till it reached the railway line. The cause of decay was the occasion of frequent speculations and suggestions. In these circumstances the writer resolved to avail himself of his opportunities for determining, if possible, which of numerous alleged causes was the true one.

1. *Flat, wet ground.*—One of the suggestions made to explain the cause of so many forest trees decaying and dying was, that growing on flat land, where water lodged for a long time, the trees were drowned. That such a result would take place in certain circumstances may be readily granted. A few observations, however, afforded conclusive proof that the explanation sought was not yet found, for on the slopes of the Cargerie and Woodbourne Creeks the trees were dying, although no water lodged permanently about their roots; while on the very flat land, extending westward from the railway line about Meredith, the trees were not dying, although in wet seasons they might be described as standing for months in the water.

2. *Seasons of drought.*—That seasons of drought prolonged indefinitely must destroy whole forests need not be questioned for a moment. But again, observation made the result clear that such drought as had been in operation in the district was not the cause which was destroying so many trees. There was the patent fact that while hundreds of trees were dying from week to week, there were within a few hundred yards of them multitudes not

visibly affected by the destroying agent, whatever it was. Now supposing drought to be the agent, it could not have acted so unequally. Still further, when the drought ended, the decay continued among the trees between 1870 and 1874. This was proof that the particular cause of decay in this case, at least, was independent of drought.

A point, however, in connection with dry seasons may here be noted. When waterholes are dried up, the opossums are compelled to congregate in the neighbourhood of permanent water. This concentrates their ravages upon the leaves of the gum-tree forests, and along with drought would help to account for trees dying near permanent water, a phenomenon which has been very puzzling to observers in this matter.

3. *Bush fires.*—Great conflagrations took place in 1863 and 1865, the flames sweeping over a large portion of country to the west of the railway line in the Meredith District. Numbers of the trees for a time seemed as if they had been fatally injured. The leaves became of a sickly yellow colour, very like the hue presented by those on trees which have been ringbarked. The trees, however, in this case did not die, except in a few instances. A large number of shoots burst forth from the main trunk of the trees which survived the scorching. In two or three seasons the aspect of the trees was thus considerably changed. In the course of seven or eight seasons this change was great enough to present quite a new appearance of the forest to one passing often through it. The luxuriant development of foliage low down on the barrels of the trees gave the forest a far more dense appearance than it had before. But the decay among the trees continued long after those fatally injured by the bush fire had died away, and after those partially injured by the scorching had recovered. Trees which had stood against both droughts and fires in 1863 and 1865 were dying in thousands in a comparatively favourable season in 1871.

4. *Difference of soil.*—As to this explanation, it was easy to point out places where the living and the dying trees were on the same soil. But it was further urged that as the larger and older trees struck their roots downwards they came to a different soil from that at the surface. The reply to this suggestion was that vigorous-looking and luxuriant young trees were smitten by the destructive agency, whatever it was, while close by scarred veterans escaped. The young trees had not had time to strike their roots so deep into the prevailing soil or soils as the older ones.

5. *Sheep manure.*—That powerful chemical decoctions arising from sheep manure would be sufficient to burn and kill the roots of gum-trees may be likely enough if the agents could be shown to operate in sufficient quantity and over the areas on which the trees are dying. Sheep-yards have been pointed to as affording

illustration in the case. In an old sheep-yard near some slate quarries on the river Moorabool, visited by the writer in 1870, the trees were found decaying, while outside this narrow space there seemed to be nothing interfering with the vigour of the trees. But plainly if it required a number of inches of manure to supply the chemical agents to account for the destruction of the trees inside the sheep-yards, there was no such supply spreading uniformly over hundreds and thousands of acres where trees had been dying. But upon making inquiry from a man who was removing the manure, a very strong doubt arose as to whether it was any chemical decoction which burnt and killed the roots of the trees. Several inches of sheep manure acted as a close matting which prevented both heat and rain from reaching the surface of the ground beneath. Thus the cracks made in seasons of drought were prevented by this matting from being made; also, little or no rain-water soaked through the thick matting of manure, and what did soak through was not received into deep cracks to circulate about the roots of the trees. From these observations it would appear that the few trees in the sheep-yard were dying of drought rather than by any powerful chemical appliances at their roots. The earth about them became as cement, and so they appear to have perished from want of sufficient supply of aqueous nourishment. But again, as regards the alleged cause, sheep manure, what might possibly explain a few acres will not explain what was taking place in regard to trees over thousands of acres.

6. *The white ant.*—This destructive creature had made its appearance on the other side of the river Leigh about twelve or fifteen years before 1874. There can be no doubt about its capacity to do the work which is under inquiry. Still there was the question—was this the actual agent in the case? But if there be some thousands or millions of white ants devouring a tree, there is no need of a powerful microscope to discover them. A good axe is sufficient as an instrument of investigation. Thousands of apparently vigorous young trees have evidently been smitten by the destroying agent, and afford abundant scope for observations. The axe is applied, some dead trees are cut down, split in pieces, their roots are cut up, and a sharp outlook kept for the destructive white ant, but no sign of this agent is discovered as doing the work in question. Moreover, in 1872, a woodman was engaged in cutting down firewood in the forest, and inquiry was made of him as to the cause of the decay in the timber. His reply was conclusive that the cause was not the white ant. His observations led him to ascribe the decay, which so many people were noticing, to a *blight, which was destroying the leaves.* Clearly, the white ant did not supply the explanation sought. As to the "blight," more will transpire regarding it in the sequel.

7. *Caterpillars destroying the bark.*—There are some caterpillars which grow several inches in length whose destructive powers are considerable. A whole colony of them, making parallel roads as they eat their way round the barrel of a tree, devouring both bark and sap-wood, are quite sufficient to kill the tree. But the number of trees actually killed in this way, so far as the writer's observations extended in the Meredith district, was very small. On the other hand, there were thousands of young trees dying, and when the bark peeled off them, leaving the white stems, there was often not a caterpillar track to be seen.

The foregoing are some of the explanations which were put forth in various ways by those whose attention had been arrested by the extensive decay among the Australian forests. By continuous observations the writer was able to secure data on the strength of which he concluded that, however effective some of the alleged causes might be in certain circumstances, they were not the causes in operation over the field which he was subjecting to examination. But while the white man was making his guesses in the matter some one had put the question to the black man, and received an answer which may take its turn for investigation.

8. *Ravages of opossums.*—The reply of the aboriginal when consulted on the matter was "too many big one 'possum." The meaning of this oracle was, in effect, that owing to the multiplication of the opossums, their ravages amongst the leaves of the trees were extensive enough to account for the destruction of the trees. So many other explanations having failed, it was only reasonable to give this one a fair trial. To start the matter, some observations of a general character were made, to ascertain whether the alleged cause presented any possibility of being adequate to account for the work of destruction occasioning the inquiry. By observing some of the smaller branches of the trees, breaking them off and counting the leaves after having made a series of approximate proportions between the branches counted and all the remainder of the tree, a rough estimate was formed of the number of leaves on the whole tree. The smaller trees gave a result of about 70,000 leaves, while the larger gave 130,000. The mean between these was 100,000. Then, as to the amount of destruction which an opossum could do in one night, it was in the first instance assumed as a guess that fifty leaves would not be too high an estimate for each opossum. According to this calculation 2,000 opossums would destroy one tree per night, or 365 in the year. Allowing eighteen trees to an acre, the foregoing figures would involve the destruction of every leaf on all the trees on a space of 20 acres. As to the numbers of the opossums in the district under consideration as well as generally there were sundry sources of information. During 1865 an active man was engaged in a profitable employment, shooting

opossums in the Meredith district for the sake of the skins, in order to make rugs. In the Woodbourne Forest he would shoot seventy or eighty per night in the course of three or four hours. Yet the space cleared in this way would not form more than the merest fraction of a square mile. Again, a farmer at Lethbridge informed the writer that he was much perplexed to know what was destroying his wheat while it was standing in sheaves in the field. The depredations of cockatoos and parrots were of course soon mentioned and credited with the results. But going out one moonlight night about 10 o'clock to visit his field, he found the ground before him darkened with the multitude of opossums which his visit disturbed. There must have been 200 hurrying away before him. About a score ran up the first stump, and he succeeded in killing some of them. These depredators, in the course of a fortnight, had destroyed about 30 bushels of wheat. Generally, as to the numbers of opossums in the Australian forests, some idea may be formed from the advertisements which were appearing at the time in the newspapers, for a thousand dozen skins at a time. So far, then, no impassable barrier obtrudes itself in the way of the aboriginal explanation. Let it therefore be followed out still further.

The opossums and the dying trees.—But now, coming more closely to the particular sphere of operations, the question very properly arises—were there evidences, especially where the trees were dying, of the presence of opossums in numbers sufficient to account for the work of destruction done? It became a point of importance systematically to examine the trunk of every tree which appeared to be smitten with the agent which was producing the results under examination. The multitudinous scratches on the bark of the tree was proof instantaneous that hosts of opossums had found their way up the tree, whether they had or had not done any work of destruction on the leaves. The scratches were generally at an angle, and not straight up and down. Also, when the opossum had sprung up, his sharp claws grazed along the bark, sometimes for an inch or two, deepening gradually till they sank into the bark and afforded sufficient hold for the animal to rest his weight and give another spring upwards. While the whole surface of the bark of the tree at its lower extremity was thus marked with myriads of scratches, it is to be remembered that the thin outer bark on which the marks are made disappear by peeling off every season. Hence the numbers of scratches observed are not the accumulations of years. That accumulation, however, can be seen on the hard barrels of trees which have died, and from which the bark has fallen. In such a case there is a network of minute scratches in countless numbers, covering square yards of surface. Often large spaces which had been charred by bush fires have become almost white, the fact being that almost

every particle of the charred bare surface had been scraped off by the frequency of the operation of the claws of the opossum. The reason for the thoroughfare up and down these dead trees was found in the fact that there were hollow branches in which the opossums took shelter during the day-time. Even in the case of trees which have rough bark—as those called "mess-mate" and "stringy-bark," the effects of the opossum claws become quite visible. The more dull-coloured outer shaggy bark is more or less torn off during the numerous ascents of the opossums, and the brighter coloured bark beneath is revealed, so that the highway of the animals is discernible a hundred yards away.

The leaves of the dying trees.—As observations were continued, a great difference was noticed between the leaves of those trees which were dying from the unknown cause and those which were dying in consequence of having been ringbarked. In the latter case the leaves would fade, assume a sickly yellow colour, then the more ashy hue, and at last drop off. Meanwhile each individual leaf presented its full outline, but it was quite otherwise with the leaves of the trees which were dying from the unknown cause. In this case each individual leaf appeared to be reduced to the mere skeleton of itself. This thinning process affected the appearance of the whole tree, and gave it what for convenience may be called a "spectral" appearance; sometimes a single branch would present this appearance, and generally such branch would die, although the whole tree might not die. In almost all cases in which the "spectral" appearance extended to the whole tree, decay and death were the result. In some few cases the peculiarity was observed that after all the "spectral" leaves had fallen off a few handfuls or very small tufts of leaves would still remain for a time on the top of the topmost branches.

What mutilates the leaves of the dying trees.—When the leaves of the dying trees were individually examined, it was found that they had been systematically injured. Every leaf was torn, and the gashes in one or both sides extending from the midrib gave only too plain evidence that a large, often the larger, part of the substance of the leaf had been torn away. The midrib generally, not always, remained throughout its whole length, but the softer material constituting the expanse of the leaf was nearly all removed. Such treatment of each leaf on the tree of the most luxuriant growth was obviously quite sufficient to produce the "spectral" appearance already described. Here also, it is pretty clear, that a probable explanation was obtained of the so-called "blight" to which the woodman ascribed the decay among the trees.

But now we have to face the question directly, what agent was destroying the leaves in the manner above described? One ready suggestion is that caterpillars might do the work. The action of these depredators would, of course, be different from that already

considered in devouring the bark and sap-wood and so effectually destroying the circulation of the tree as if it had been ringbarked. In the case now under notice the fatal operation would take place in the leaves. There is no doubt about the capacity of legions of caterpillars to destroy every green thing before them. But as a matter of fact there was no very unusual development of such creatures in the locality in question during 1862-74. In the Lethbridge neighbourhood a small copper-coloured beetle was committing ravages in the forest, as will be noticed afterwards, but neither caterpillar, nor beetle, nor even locust, occurred in such numbers about Meredith as to account for the destruction of forest trees which occurred in that district.

But on still more minute examination a great difference is found between the effects produced on leaves by caterpillars or insects, and the effect produced on the leaves of the "spectral" trees. There is a general regularity about the latter which contrasts completely with the capriciousness of the former. When caterpillars or insects are the agents, the leaf is eaten now at the edge, now in the middle, or both ways. At one place a small hole is bored, at another a large one. At one place a gash is cut in the outer rim of the leaf, at another a narrow inlet is cut and a winding course pursued between the outer edge and the midrib. While there is every variety of capriciousness in these cases, it is quite otherwise with the leaves from the "spectral" tree. There is one pervading method of procedure, namely, to take as it were a succession of *bites* first out of one side of the leaf, then out of the other, leaving the mere skeleton, consisting of a midrib and small portions of the leaf, attached thereto. Seven or eight semicircular excavations of this kind can often be counted on each side of the leaf. In the case of the caterpillars or insects, the sharp horny mandibles eat their way and cut out small morsels from the leaf without any tearing process. In the other case the fibrous and stringy parts of the leaf are left behind as if some far larger and more powerful agent had been at work.

Leaves bitten by captive opossum present the same appearance as leaves on "spectral" trees.—To advance the inquiry a stage further, the writer bethought himself of the expedient of capturing an opossum and observing the manner in which he dealt with the leaves on which he was to be fed. Direct comparison could then be made between the actual results obtained from the opossum and those exhibited in the leaves taken from "spectral" trees. Before the opossum got his allowance of foliage the leaves on the branch were counted. It was now found that one opossum more or less devoured 200 leaves in a single night instead of the 50 which had been previously allowed him. When a rather scanty supply was given he would devour every particle of the leaf, also the more tender twigs, and even some of the bark of the branch.

His predilection for different kinds of leaves was easily tested. He would eat cherry-tree, lightwood, and honeysuckle rather than starve, but the common gum-tree of the district was plainly his favourite food. He required water, and could be heard lapping it up like a cat. When an ample supply was given him, the manner in which he treated the leaves was soon found to be quite closely similar to the manner in which the leaves on the "spectral" trees had been treated. The marks left as by an animal biting the leaves with a mouth about the size of the mouth of an opossum was unmistakably of the same character in both cases.

Explanations.—Some points which came to the surface during the previous observations may now be shortly considered in the light of the supposition that the opossum has been the operator in the destruction of trees in the locality already described. There was the case of the trees from which all the leaves had disappeared, except a few very small tufts on the topmost branches. But in most cases there was not even a topmost tuft of leaves which had not been visited with the lacerating agent which gave the leaves their "spectral" appearance. The question arises how could opossums, which are bulky and weighty creatures, reach the topmost of slender branches to nibble the leaves? To this it is to be replied that the very young opossums could secure foothold where the weight of the older ones would break the branches. But more than this, the opossum is peculiarly fitted for reaching leaves at the extremity of the slenderest branches. He can use his fore feet practically as hands, can catch hold of a slender branch and bend it towards him. He can thus nibble the leaves and let go the branch to return to its former position.

Another apparent difficulty can be quite well explained on the supposition that the depredations of opossums are sufficient to destroy both leaves and trees. The writer has noticed a tree which had been growing quite close to a waterhole decaying and dying, while those further from the water were not seriously affected. It was so far a season of drought that much of the ordinary water supply had been dried up. This caused the opossums to gather in greater numbers at this particular waterhole in which there was a more permanent supply of water. The tree situated so near the meeting-place of the opossums was thus inevitably exposed to the combined ravages of a large number of the depredators and was destroyed. This on a larger scale is just what was happening to whole forests.

An explanation can now also be obtained to show why, in some localities, so many young trees were dying, while scarred veterans still survived. The writer scores of times observed a tree of considerable size and age in the Woodbourne Forest, keeping its place while great numbers of apparently healthy young trees were smitten as with some plague and died. A great scar on this tree

had laid one side bare, while on the opposite side a rectangular sheet of bark had been taken off by the aborigines for the purpose of making a pegging board in order to stretch out opossum skins. The larger bared surface had dried, rotted, and split through the middle. As the winds played upon this veteran of the forest, and as he swayed about, he groaned with age and weakness. Still, through drought and all other causes of destruction to tree life he kept his place. Yet, not far off, not many hundreds of yards, large numbers of apparently healthy trees of not more than fifteen or twenty seasons, were to be seen smitten with decay and dying. When the bark peels off these young trees not a blemish is to be seen. Neither caterpillar nor white ant has touched them. The abundant spread of foliago on every branch while alive, the absence of even one single dead limb, was evidence that there was no internal weakness till the fatal so-called "blight" began to make its appearance on the leaves. An explanation of these various phenomena is fairly supplied by the opossums. They prefer the fresh, sappy leaves of the young trees to the leathery leaves of the hardy veteran already described.

The relationship as one of cause and effect between the disappearing of the aborigines and the multiplication of the opossums may be briefly noticed. If a balance of arrangements had been reached during previous centuries, it can be very easily believed that the advent of the white man has disturbed that balance. The aboriginal tribes that roamed the Australian forests were supported largely by the opossum as an article of food. The animal existed in large numbers, and was much more easily caught than the kangaroo. About forty years ago there were 200 aborigines inhabiting the territory comprised within the County Grant, in Victoria. It is no extravagant allowance that fifty opossums were required daily to feed that assemblage. But this would imply the consumption of 18,000 opossums every year. Also it has been seen that one opossum consumes 200 leaves of a tree in a single night. Then using the figures which have already appeared in the foregoing pages, the result is reached that these 18,000 opossums would destroy upwards of 13,000 trees, and lay bare a space of upwards of 700 acres, or considerably more than a square mile.

Ravages of copper-coloured Beetle at Lethbridge.

It has been stated already that a small copper-coloured beetle had made its appearance at Lethbridge, 9 miles south of Meredith, and seemed to have some connection with a work of destruction which was taking place in a forest of large and tall trees in that district. These beetles had been seen hovering in clouds over the trees. In company with the gentleman who had drawn attention to the matter the writer visited the locality, and large

numbers of the beetles were still to be seen. In due time the operators were discovered at their work. They were about a quarter of an inch long, and very active. Two of these small coleopterous insects would place themselves exactly opposite each other on a tender shoot of new growth, and quite rapidly, with their small mandibles, would peel off every particle of the bark, leaving nothing but the woody little stem. This process took place on the whole of the young shoots of large trees, so that the top of the tree presented so many bunches, as if of small bare wires sticking up into the air. From what the writer saw, as well as from what he learnt from his informant, as to the countless multitudes of the beetles, there was little, indeed no doubt left, that these depredators were quite sufficient to destroy whole forests of very large trees.

Perhaps it may not be without interest to conclude this paper by noticing a very curious passage in a communication which appeared about thirty years ago from the pen of Blandowski, a scientist who was some time in the Australian Colonies. It occurs in his "Personal Observations in the central parts of Victoria," which were published in the transactions of the Philosophical Society of the Colony just named, for the year 1855, page 72. His own words may be quoted, as they give a most singular suggestion by way of accounting for trees decaying in groups in the midst of forests. He says, "During my stay at Seymour I met with a camp of aborigines, by whom I was willingly accompanied to that place. Having observed an unusually large number of dead trees in a forest which we passed through, I was induced to inquire the cause of so peculiar a circumstance, and was informed, in reply, that it was a spot on which a once very numerous Goulburn tribe was overwhelmed by a still more powerful tribe inhabiting the banks of the Murray. Each of the dead trees represents a member of the extinguished clan, and the custom is still maintained by those tribes neighbouring the Goulburn, and has its origin in the following superstitious ceremony :—Upon a youth arriving at manhood he is conducted by three of the leaders of his tribe into the recesses of the woods, where he remains *two days* and *one night*. Being furnished with a piece of wood he knocks out two of the teeth of his upper front jaw, and on returning to the camp carefully consigns them to his mother. The youth then again retires into the forest, and remains absent *two nights* and *one day*, during which his mother having selected a young gum-tree inserts the teeth in the bark, in the fork of two of the topmost branches. This tree is made known only to certain persons of the tribe, and is strictly kept from the knowledge of the youth himself. In case the person to whom the tree is thus dedicated dies the foot of it is stripped of its bark, and it is killed by the application of fire, thus becoming a monument of the deceased. Hence we need no longer be

surprised at so frequently finding groups of dead trees in healthy and verdant forests, and surrounded by luxuriant vegetation."

If Blandowski regarded the aboriginal custom which he records as sufficient to account for the groups of decaying trees to be met with from time to time in the Australian forests, he must have greatly over-estimated the numbers of the aboriginals. About forty years ago a census was taken of the primitive sable occupants of the County of Grant, in Victoria, and the Government return is set down at 200. By the year 1874 that number had dwindled down to a very small remnant. Now, supposing that when the numbers were largest, every man, woman, and child had been provided with a sacred tree, there would have been just 200 of such trees. But between 1862 and 1874 the writer saw thousands of trees dying and dead in the Meredith district. Quite clearly the cause is not sufficient to account for the results observed. But even in regard to the locality to which Blandowski refers, his own account leaves one insuperable difficulty in the way of the explanation suggested by him. For when that powerful Goulburn tribe were overwhelmed and massacred, it is plain that the secret knowledge so closely associated with the destiny of the different members of the tribe must of necessity have perished. Then the question arises—who performed the office of barking the tree at its root and destroying its vitality by fire. Perhaps after all we may reduce Blandowski's suggestion to the footing of a semi-mythological version of the relation between the disappearance of the aborigines and of the eucalypt forests through which they roamed. For unrecorded ages the weird wild-fires that accompanied the ceremonies of the bora and the corroboree had lit up the darkness of the forest till at last they ceased for ever. As years roll on some strange fatality seems to overtake the forest itself. Some blight smites it in the leaves, the trees dwindle into mere spectres, and at last die. What mysterious links in the chain of cause and effect have thus associated the disappearance of the aborigines with the decay and death of the forest also? There really is, as it turns out, a connection between the two, though not exactly as in Blandowski's account. The tooth of the blackfellow operated on the opossum, and the tooth of the opossum operated on the leaves of the eucalypt. The former of these two factors is now struck out of account, and that leaves much larger scope for the operation of the second factor. The great increase of opossums, through the disappearance of the aborigines, means more extensive destruction of the gum-trees. And what disturbed that equipoise of forces which, for unrecorded ages, had reached a certain normal adjustment between all the forces and factors concerned in the case? The new disturbing factor was the white man, the resistless white man, before whom disappear all obstacles that come in his way, whether black men, opossums, or eucalypt forests.

DISCUSSION.

Mr. MILNER STEPHEN, F.G.S., expressed his general concurrence in the opinions of the rev. gentleman, as to the causes of the decay of large areas of forest trees in the Australian Colonies, which he (Mr. M. S.) had often observed in his travels, on circuit or otherwise, during the last fifty years. In his younger days he had for several years kept pet opossums, and had observed the great mass of young gum leaves they nightly consumed, making it a wearisome task at length to gather a sufficient supply to satisfy their voracity. He well remembered the clouds of beetles which covered every bush in the Domain, more than a generation ago, which honey-combed every leaf, precisely like those shown in the diagrams prepared by the author. These two causes of destruction, added to the ravages of the grubs perforating the bark and consuming the sap or life-blood of the trees, and the deleterious effects of their standing often in water covering stiff clay, with the ravages of bush fires, and the tornadoes, which often stripped off every limb through a wide belt of timber, miles in extent, seemed sufficient to account for the wholesale destruction of trees, so carefully noted and described by Mr. MacPherson. He (Mr. M. S.) remembered, some ten years ago, driving for about 14 miles through a belt of trees about a quarter of a mile wide, near Young, which had recently been stripped of every branch, by a tornado or cyclone, down to their bare poles.

Mr. DEAN asked Mr. MacPherson whether his attention had been called to a belt of dead trees between Goulburn and Queanbeyan. The belt was some chains wide and several miles long, and as straight as any street in the world; all of the trees were completely dead, not by ringbarking but by some other cause. Mr. Dean also mentioned that the beautiful wattle-trees so common on the Kurrajong usually die in from seven to ten years. In this case it has been proved that a grub enters the tree when young and gradually eats the life out of it.

Mr. RUSSELL, F.R.A.S., Government Astronomer, said, I am sure all the members of the Society are with me in proposing a vote of thanks to the Rev. Peter MacPherson for the valuable paper he has read to us this evening. The subject is one of very great importance to the Colony and should be fully investigated, for if our forests are to die off in the wholesale manner which has been reported in some parts of this and the neighbouring Colonies it will not be long before we shall have to go to great outlay in planting new trees. Every effort therefore to trace the cause of death in these trees is a step in the right direction. Mr. MacPherson tells us that he has practically confined his investigation to the district in which he resided, and finds proof that there it is mainly if not entirely due to the ravages of opossums which have multiplied rapidly as the black man disappeared. I have not had any

opportunity of investigating this myself, but I recollect that about twenty years since, when the same thing was going on rapidly in parts of this Colony, many theories were put forward to account for it. Some thought it due to grubs which got between the bark and wood and ate out the life of the tree, but all who have been in the bush know that grubs eat between the bark and woods of trees cut down or ringbarked, and seem only to do it when the sap has ceased to circulate. Another theory laid the cause to some disease in the roots similar to that affecting orange trees at the same time; this was, I believe, the view held by the late Sir William M'Arthur, a very close observer of natural phenomena, and he had trenches cut between the healthy and dying trees, with a view to stopping the progress of the disease through the ground, but without producing the desired effect.

Mr. MacPherson has shown us very clearly that where he resided in Victoria opossums were the cause of death in the gum-trees, and I trust others who have observed in other places will publish the results of their investigations, and then we may be able to see if the cause is the same everywhere. It does not appear to affect all the forest at the same time; large patches die off while all round there is the usual healthy vegetation, and if we are to judge by the patches of bare country the same thing has gone on at intervals for a very long time past.

It seems strange that these bare patches of country should remain so; it suggests some change in the soil which renders it unfit to support tree life. The subject is, however, a wide one, and I am not prepared to enter fully into the discussion of it, but I hope that Mr. MacPherson's example will be followed by many who are in a position to throw light upon this important matter.

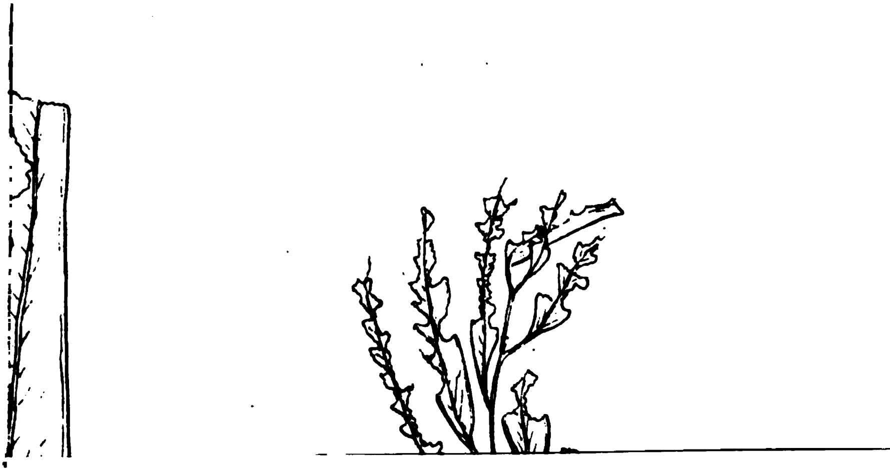
The PRESIDENT (Prof. Liversidge, F.R.S.), in conveying the thanks of the Society to the author for his valuable and suggestive paper, stated that he thought the decay and death of the trees might in some cases be due to the exhaustion of the soil for those particular trees (eucalypts), although the soil might still be able to support a flourishing growth of other forest trees; and that to obtain the best growth of trees it is necessary to have a "rotation of crops" just as in farming. In fact such a rotation seems to have arisen naturally over various areas of the earth's surface, the buried remains of oak forests being met with in the Cambridgeshire Fen district and elsewhere.

It is also known that the present forest vegetation of Sweden and Norway has been preceded by others which have died out over large areas; the former forests of beech, oak, &c., having been successively replaced by pine forests.

He also mentioned, although a matter not directly connected with the subject of the paper, that in his opinion the reason why the planting of gum-trees in Italy and elsewhere has been found

to be beneficial in removing malaria from marshy places, is not so much on account of any essential oil which they may give off, as to the fact that, while they probably evaporate as much or more water from their leaves, they, from the vertical or pendant position of the leaves, unlike other trees, cast but little shade. The ground underneath a gum-tree is never damp and moist in dry weather as it is under ordinary European and other shade-giving trees, so that an area planted with such trees is exposed to the combined drying influence of the sun and to the absorption of water by the roots and subsequent evaporation from the leaves.

It has been suggested that the peculiar bluish haze seen in the Australian bush is also due to this essential oil; but from an experiment made in conjunction with Mr. Russell, the spectroscope gave no indication of its presence in the atmosphere. The matter, however, is worthy of further investigation.



History of Floods in the Hawkesbury River.

By J. P. Josephson, A.M.I.C.E.

[*Read before the Royal Society of N.S.W., 2 September, 1885.*]

The basin of the Hawkesbury is very curiously formed and constitutes one of the geographical peculiarities of New South Wales. It consists of three slopes inclining inwards, a north, a west, and east slope. The main stream comes from the north slope. It is formed in the first instance, of the Wollondilly, and its south branch, the Mulwarree. In its progress north the Wollondilly is joined by the Cookbundoon from the left, and by the Wingecarribe from the right, bank. It then traverses the remarkable sunk valley called Burragorang, still keeping its north direction. The next important tributary, Cox's River, collects the waters drained from the south portion of the Blue Mountains, flows in a general east direction, and joins the Wollondilly, the united stream then assuming the name of Warragamba. In the next place several small streams, rising in the west of the Illawarra Range, unite their waters and form the Cowpasture River, which flows west into the Warragamba. The peculiarity about these western flowing waters is, that some of them rise within 2 miles of the sea (coast) shore, and flow in the opposite direction from it. The main stream is now called the Nepean, preserving that name until joined by the Grose from the Blue Mountains, when it is designated the Hawkesbury. After receiving the Colo and the Macdonald from the Blue Mountains, the Hawkesbury turns suddenly east, and discharges its waters into Broken Bay, which is about 20 miles north of Sydney Heads.

The lower portion of the Hawkesbury is navigable, and the scenery on its banks is remarkable for its beauty and picturesque appearance. The total course of the Hawkesbury is 330 miles, and it drains an area of 8,700 square miles. Its principal tributaries are the Macdonald, Grose, Colo, Nepean, and Warragamba Rivers, and the Mangrove, Breakfast, Gunderman, Myrtle, Billong, Currency, Cattai, South, and Rickaby's Creeks. Sandstone and shale country.

Some of the more recent floods have been carefully surveyed, and on the plan in the appendix will be found the details of these surveys, showing the land actually under water in 1867, here

shaded blue. Also a certain plan of the district will be found showing the character of the country; and a diagram showing relative heights of floods, and variations in rainfall.

Many of the recent Hawkesbury floods produce little or no change in the river bed, but there are many indications of changes in the past. Even new and old channels may be seen on the Richmond flats not yet filled up, and the present course has been cut through an older deposit of gravel and soil. Some very interesting facts have been recorded since the district has been settled. In 1867 5 acres of one paddock and 14 acres of another were washed away in one sweep. In 1870, 50 acres out of 100 acres of farming was washed away, and at the same time the confluence of the Hawkesbury and Grose Rivers was wholly changed, and is now a quarter of a mile to the eastward of the old junction; all the cutting is in the south side towards the town of Richmond, and three very remarkable landslips took place on that side, one of which was witnessed by Mr. G. M. Pitt and his father. When standing on the south side, and hearing a noise looked towards the river, then in flood, and saw about quarter acre with oak trees upon it sliding rapidly into the stream through an opening in the immediate bank of the river. The opening was much narrower than the moving land, but this seemed to be in a soft and yielding or pasty state, and so found its way through the narrow opening. The trees on the slip did not fall over into the stream, but seemed gradually to sink down into the water. The marks of these slips were visible in August, 1876, and then the opening in the bank of one at least seemed to be less than quarter of the width of the land that had slipped through it.

Having devoted some time to the study of the effects of floods on the Hawkesbury River, I thought the following historical notes of the various floods, &c., which have been recorded, would perhaps be interesting to the Members of the Royal Society.

When the Governor of this Colony visited the Hawkesbury in 1789 he saw signs of floods 20 feet to 40 feet above the then level; and the colonists had not long settled on the river before they were alarmed by a flood which came on in the night without any warning. This was the flood of March 3rd, 1799, which we are told that the settlers saw no indication of such a disaster, and woke up one morning to find the whole country under water, and many of them were unable to get away from their houses until rescued with boats. It is said that the blacks knew that a flood was coming on, but the whites saw no signs of it when they retired for the night.

An ABSTRACT showing heights of Floods from years 1795 to 1881.

Year.	Date.	Height of Floods. ft. in.	Number of Lives lost.	Remarks.
1795	January	Not measured	......	Several settlers suffered much.
1795	August	" "	......	Fences carried away.
1799	3 March	50 0	1	Above mean level.
1800	March	Not measured	......	
1801	2 March	" "	1	A very high flood. During first three months of 1801 the floods destroyed property, &c.—£23,000 nearly.
1801	August	" "	......	
1805	10 February	" "	......	Up to banks.
1805	17 March	" "	......	Low lands around South Creek flooded; toll-house submerged.
1805	24 March	" "	......	Covered South Creek Bridge.
1805	6 November	" "	......	Rose 3 feet in one hour from heavy rains in the mountains.
1806	3 March	" "	......	Violent gale from S.E., E., and N.E., with deluges of rain.
1806	22 March	47½ 0	5	Loss of property, £35,000. Bread sold at 4s. 6d. and 5s. the 2-lb. loaf. Wheat rose to 70s. and 80s. per bushel; one case £7 was paid for a bushel of seed wheat.
1806	23 April	Not measured	......	South Creek banks overflowed.
1806	19 October	30 0	......	
1808	13 November	20 0	......	Above usual level.
1809	15 May	12 0	......	" " "
1809	25 May	Not measured	......	Reached flood of 1801; rose 4 feet per hour.
1809	1 August	47½ 0	8	
1810	14 July	Not measured	......	South Creek flooded; 12 feet above bridge.
1811	25 March	" "	......	
1812	9 March	" "	......	Banks of South Creek overflowed.

Year.	Date.	Height of Floods. ft. in.	Number of Lives lost.	Remarks.
1812	25 November	Not measured	......	Banks of South Creek overflowed.
1816	24 February	" "	......	Small fresh.
1816	2 June	45½ 0	......	2 feet less August flood, 1809.
1816	27 June	Not measured	......	Small fresh.
1817	26 February	" "	2	Within 10 inches or 12 inches of August flood, 1809.
1819	12 February	" "	2	Great deal of maize destroyed.
1819	20 February	" "	......	Nearly as high as flood, March, 1806.
1819	12 June	" "	......	Large flood.
1820	24 June	" "	......	No damage done.
1820	6 July	" "	......	" " "
1821	17 September	" "	......	South Creek flooded.
1826	19 January	" "	......	South Creek heavily flooded.
1826	6 September	" "	......	South Creek flooded. Carried away hand-railing of temporary bridge at Windsor.
1830	7 April	" "	4	Ascended as high as Richmond town, doing great damage.
1830	13 November	" "	......	Banks of river under water.
1830	27 November	" "	......	River rose within 10 feet of its bank.
1831	23 April	" "	......	Flood being immense, and at places terrific.
1832	24 March	" "	......	Banker.
1833	24 April	" "	......	Great rise in river.
1839	9 September	9 0	......	Above tidal level.
1857	29 July	32 1	1	Water rose 30 feet in twelve hours. Highest flood known during a period of forty years. 2s. 6d. a head was paid for conveying passengers across the river, and £1 for horses per head.
1857	22 August	37 1	......	The large arches of Fitzroy Bridge almost covered. Highest point reached for many years.

Year.	Date.	Height of Floods.	Number of Lives lost.	Remarks.
		ft. in.		
1858	9 October	Not measured	......	Rose above ordinary level.
1859	22 February	" "	......	Fresh in river.
1859	4 September	" "	......	" "
1860	12 February	26 9	......	The Cornwallis Bridge, over Rickaby's Creek, was swept away. The water was about 1 foot deep on the floor of Fitzroy Bridge.
1860	29 April	36 8	......	
1860	26 July	34 3	......	
1860	19 November	35 4	1	
1861	5 April	Not measured	......	
1861	30 "	26 8	......	
1861	August...............	Not measured	......	Small flood.
1863	17 February	" "	......	" "
1864	1 March	22 4	......	
1864	2 May	Not measured	......	" "
1864	4 June.................	22 1	......	
1864	13 June.................	47 4	......	It was carefully estimated that not less than £130,000 worth of property had been destroyed by the flood, and upwards of 250 families, representing more than 1,000 souls, had been thrown into distress.
1864	16 July	35 6	......	
1866	15 June.................	26 0	......	
1866	12 July	26 9	......	
1867	14, 15 April	20 6	......	11 April; in fresh 4 or 5 days.
1867	30 April	25 8	......	

Year.	Date.	Height of Floods.		Number of Lives lost.	Remarks.
		ft.	in.		
1867	23 June	62	7	6	1,000 valuable horses were drowned in the neighbourhood of Windsor. The greatest disaster was in the covering over of the rich alluvial deposit with a thick layer of sand (white), the depth of which varied from 1 ft. to 15 ft. It was on this flat that a very high telegraph pole stood to carry the Maitland and Wollombi wires. This was sufficiently high to enable vessels to pass underneath it; this was washed down and the wire parted as though it was thread. The magnitude of this flood was in a great measure due to the fact that the gales and rains were both heavy from the east.
1867	9 September	15	4	......	
1867	8 October	Not measured		......	Small flood.
1868	18 February	29	2	......	
1868	21 July	Not measured		......	South Creek about 2 ft. above ordinary level.
1869	5 April	"	"	......	Small flood.
1869	9 May	36	3	......	Level with floor of Fitzroy Bridge about sunset 8th inst.
1869	19 June	Not measured		......	Small flood.
1869	20 July	"	"	......	" "
1870	11 March	10	0	......	" "
1870	19, 20 March	21	9	......	Nearly up to floor of Fitzroy Bridge.
1870	23 March	21	7	......	
1870	31 March, 1 April	27	6	......	Rain fell on 27 days in March, total fall being 16·98 in. (Windsor only).
1870	25, 26 April	19	0	......	
1870	28 April	44	4	......	The water rose suddenly during the night; the people could not save anything but themselves.
1870	13, 14 May	34	9	......	Water rose from 4 in. to 18 in. per hour.
1870	25 May	23	6	......	

Year.	Date.	Height of Floods.	Number of Lives lost.	Remarks.
		ft. in.		
1870	4 June	20 0	......	
1870	18 July	Not measured	......	A small fresh in river.
1870	August	„ „	......	„ „ „ beginning of month.
1870	9, 15 October	„ „	......	„ „ „
1870	21 October	„ „	......	„ „ „
1870	21 November	25 8	......	
1870	26 December	Not measured	......	Maximum about 6 or 7 ft. below floor of Fitzroy Bridge. During this year 15 floods occurred.
1871	10 January	Fresh	......	
1871	24 January	„	......	
1871	5 February	„	......	
1871	23, 24 February	„	......	
1871	19 March	„	......	
1871	30 April	31 3	......	
1871	2 May	36 4	......	Telegraph communication between Windsor and Penrith interrupted; also between Windsor and South Creek.
1871	10 May	Fresh	......	
1871	23 May	„	......	
1871	26, 27 May	„	......	This flood somewhat higher than floor of Fitzroy Bridge.
1872	17, 18 September	„	......	
1872	4, 8 October	„	......	
1872	23 November	15 6	......	South and Rickaby's Creeks flooded.
1872	6 December	13 5	......	
1872	14 „	Fresh	......	
1873	13 January	14 0	......	

Year.	Date.	Height of Floods.		Number of Lives lost.	Remarks.
		ft.	in.		
1873	26, 27 February	41	0	......	Causing numerous land-slips along the river; also depositing mud and sand as high as fences.
1873	8, 22 April	Fresh............		......	
1873	5 June..................	„		......	
1873	17, 18 June	27	4	......	Fitzroy Bridge was covered.
1873	26 July..................	15	6	......	
1873	17 November	Fresh............		......	
1874	13, 14 February	„		......	
1874	23 February	26	7	......	Clarendon and Richmond Bottoms inundated.
1874	25 March	Fresh............		......	River and creek rose 10 feet above ordinary level.
1874	4 May	„		......	„ „ „
1874	18 June..................	„		......	Rose slightly in consequence of the melting of snow up the country.
1874	28 „	„		......	
1874	6 July	„		......	
1874	August	„		......	In early part of month.
1874	25 „	„		......	
1875	March	16	0	......	In early part of month it was higher than Windsor Bridge.
1875	4 May	23	2	......	Low land covered.
1875	29, 31 May	Fresh............		......	River rose above floor of Windsor Bridge.
1875	7 June...................	38	3	......	
1875	27, 30 June	Fresh............		......	
1876	28 May	„		......	In South Creek.
1876	17 July	„		......	Above floor of Windsor Bridge.
1876	12, 13 September......	„		......	
1876	10, 11 October	„		......	The water rose to the floor of Windsor Bridge on the 10th.

Year.	Date.	Height of Floods.		Number of Lives lost.	Remarks.
		ft.	in.		
1877	2, 3 May	29	7	......	Bridge communications between Windsor and Wilberforce stopped—done by boats. The waters were 2 feet over the Fitzroy Bridge.
1877	13, 14 May	19	8	......	
1877	16 July	26	0	......	South and Eastern Creeks flooded.
1877	September	Fresh		......	Last week in this month.
1877	23 October	"		......	
1878	9, 10 February	25	9	......	
1878	3 August	Fresh		......	
1878	8, 9 September	"		......	
1878	2, 3 November	"		......	
1878	15 December	"		......	
1879	17, 18 February	"		......	
1879	7 June	"		......	
1879	9 August	"		......	
1879	29, 30 August	"		......	
1879	11 September	42	7	......	
1879	17 "	34	0	......	
1879	8, 9 October	Fresh		......	
1880	11 February	"		......	
1880	30 March	"		......	
1880	26 April	"		......	
1880	October	"		......	Beginning of month.
1880	24, 28 October	"		......	
1880	11, 19 November	"		......	
1881	11 January	"		......	
1881	5, 6 February	"		......	
1881	22 October	"		......	

SUMMARY OF FLOODS FROM 1795 TO 1881.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1795	1	...	...	...	...	...	...	1	...	...	...	...	2
1799	...	...	1	...	...	...	...	...	...	...	...	...	1
1800	...	...	1	...	...	...	...	...	...	...	...	...	1
1801	...	...	1	...	...	...	...	1	...	...	...	...	2
1805	...	1	2	...	...	...	...	...	...	...	1	...	4
1806	...	...	2	1	...	...	...	...	...	1	...	...	4
1808	...	...	...	...	...	...	...	...	...	...	1	...	1
1809	...	...	...	...	2	...	...	1	...	...	...	...	3
1810	...	...	...	...	...	...	1	...	...	...	...	...	1
1811	...	...	1	...	...	...	...	...	...	...	...	...	1
1812	...	...	1	...	...	...	...	...	...	...	1	...	2
1816	...	1	...	...	...	2	...	...	...	...	...	...	2
1817	...	1	...	...	...	...	...	...	...	...	...	...	1
1819	...	2	...	...	...	1	...	...	...	...	...	...	3
1820	...	...	...	...	...	1	1	...	...	...	...	...	2
1821	...	...	...	...	...	...	...	...	1	...	...	...	1
1826	1	...	...	...	...	...	...	...	1	...	...	...	2
1830	...	...	...	1	...	...	...	...	...	...	2	...	3
1831	...	...	...	1	...	...	...	...	...	...	...	...	1
1832	...	...	1	...	...	...	...	...	...	...	...	...	1
1834	...	...	...	1	...	...	...	...	...	...	...	...	1
1839	...	...	...	...	...	...	...	...	1	...	...	...	1
1857	...	...	...	...	...	...	1	1	...	...	...	...	2
1858	...	...	...	...	...	...	...	...	...	1	...	...	1
1859	...	1	...	...	...	...	...	...	1	...	...	...	2
1860	...	1	...	1	...	...	1	...	...	...	1	...	4
1861	...	...	...	2	...	...	...	1	...	...	...	...	3
1863	...	1	...	...	...	...	...	...	...	...	...	...	1
1864	...	...	1	...	1	2	1	...	...	...	...	...	5
1866	...	...	...	...	...	1	1	...	...	...	...	...	2
1867	...	...	...	2	...	1	...	...	1	1	...	...	5
1868	...	1	...	...	...	...	1	...	...	...	...	...	2
1869	...	...	...	1	1	1	1	...	...	...	...	...	4
1870	...	...	4	2	2	1	1	1	...	2	1	1	15
1871	2	2	1	1	4	...	...	...	...	...	...	...	10
1872	...	...	...	...	...	...	...	...	1	1	1	2	5
1873	1	1	...	1	...	2	1	...	...	...	1	...	7
1874	...	2	1	...	1	2	1	2	...	...	...	...	9
1875	...	...	1	...	2	2	...	...	...	...	...	...	5
1876	...	...	...	...	1	...	1	...	1	1	...	...	4
1877	...	...	...	...	2	...	1	...	1	1	...	...	5
1878	...	1	...	...	...	...	...	1	1	...	1	1	5
1879	...	1	...	...	...	1	...	2	2	1	...	...	7
1880	...	1	1	1	...	...	...	...	...	2	1	...	6
1881	1	1	...	...	...	...	...	...	...	1	...	...	3
Totals.	6	18	19	15	16	17	13	11	11	12	11	4	153

The greatest number of floods occurred in the month of March with a total of 19, then February with 18, and June with 17.

RAINFALL FROM YEAR 1859 TO YEAR 1881.

Year.	Goulburn.	Camden.	Windsor.	Windsor.	Kurrajong Heights.	Windsor.
	Gauge on ground.	Gauge on ground.	Gauge 6' 6" above ground.	Gauge 1' 2" above ground.	Gauge on ground.	Gauge on ground.
1850	......	......	......	......	......	......
1851	......	......	......	......	......	......
1852	......	......	......	......	......	......
1853	......	......	......	......	......	......
1854	......	......	......	......	......	......
1855	......	......	......	......	......	......
1856	......	......	......	......	......	......
1857	......	......	......	......	......	......
1858	......	......	......	......	......	......
1859	24·06	......	......	......	......	......
1860	40·52	......	......	......	......	......
1861	23·52	38·123	......	......	......	......
1862	16·35	15·259	......	......	......	15·840
1863	26·74	29·545	35·997	......	......	35·997
1864	26·42	50·620	55·030	......	......	55·040
1865	11·72	19 900	19·957	......	......	19·728
1866	No obs.	29·730	28·378	......	24·75	28·878
1867	„	43·530	44·300	......	60·25	41·300
1868	„	25·080	27·039	......	No obs.	27·039
1869	„	32·380	32·625	......	50·25	32·625
1870	„	55·740	62·513	......	111·80	62·513
1871	32·45	29·910	34·468	......	65·97	34·468
1872	29·986	28·500	25·206	......	42·97	24·254
1873	31·37	52·920	41·380	43·515	46·00	43·515
1874	26·85	37·780	32·078	32·954	40·37	32·954
1875	25·57	33·450	32·273	33·378	36·88	33·378
1876	23·34	No obs.	26·422	26·994	43·10	26·994
1877	25·574	„	35·139	35·218	46·77	35·139
1878	28·23	„	36·328	36·317	51·46	36·317
1879	33·989	„	40·149	40·890	60·88	40·899
1880	27·70	„	21·557	21·899	43·99	21·557
1881	20·48	„	27·460	27·869	41·61	27·460
Means	26·381	34·831	34·647	33·226	51·13	33·794

In conclusion I have to thank the following gentlemen, viz.: Messrs. E. O. Moriarty, Engineer-in-Chief Harbours and Rivers; H. C. Russell, Government Astronomer; and John Tebbutt, Windsor, for information supplied by them to enable me to complete my paper.

[illegible]

The Ringal of the North-western Himalaya;

By Dr. Brandis, F.R.S., late Director of the Forest-Department of British India. Communicated by Baron Ferd. von Müller, K.C.M.G., M.A., Ph.D., F.R.S. &c., Govt. Botanist, Victoria.

(Notes on two species of *Arundinaria* suitable for cultivation in New South Wales.)

[*Read before the Royal Society of N.S.W., 7 October, 1885.*]

Two species of bamboo are known from the higher mountains of the North-western Himalaya: *Arundinaria falcata*, Nees (Munro in Trans. Linn. Soc. XXVI, 26), and *Arundinaria spathiflora*, Trinius, described by Munro under the name of *Thamnocalamus spathiflorus*.

Arundinaria falcata is a small bush, not much over 6 feet high, growing at moist places in the valleys of the outer North-west Himalaya. I have found it in Kell, in the basin of the Bias-River, on tributaries of the Sutlej-River, and in the valleys of Jaunsar, leading to the Tons and Juvara-Rivers. I have never seen it at a higher level than 7,000 feet. The stems are thin and weak, and do not, as far as I know, form any article of trade. The bamboo, which is exported to the plains of Hindustan, and which is made into tubes for water, tobacco-pipes (hookah), fishing-rods, mats, baskets, is *A. spathiflora*, a much larger species, which grows from 8,000 to 10,000 feet. This is the kind commonly known as Ringal, Nagal or Ningala. In the forests of *Cedrus Deodara*, *Cupressus torulosa*, *Abies Smithiana*, *Abies Webbiana* and *Quercus semecarpifolia* it often forms a dense underwood, covering large areas on the ranges between the Rais and Bias, Bias and Sutlej, Sutlej and Tons, and Tons and Jumna Rivers. This bamboo also forms forests of its own, with a few scattered trees. Such a forest, consisting chiefly of *Arundinaria spathiflora*, I found in October, 1874, on the south side of the Kidar-Kanta Peak of the Tiri State, in a moist valley, on excellent soil, and here the stems had attained 30 feet.

Both species have a wide distribution, but as far as is known they are limited to the outer ranges with a moist climate. They have not been recorded from the drier districts beyond the Snowy Ranges. According to Munro, *A. falcata* extends from the Rais to Kumaon, and is again found on the Khasia Hills. As to eleva-

tion, the limits given by him (5,000 to 7,500 feet) accord with my own observations. *A. spathiflora* has its north-west limits on the hills between Rais and Bias, and, according to Munro, is found in Sikkim and Butan. As already stated, its limits of elevation are 8,000 to 10,000 feet.

When I wrote the Forest-Flora of North-western and Central India in 1874, my knowledge of these two species was somewhat imperfect, and the account given of them by me on that occasion was not altogether correct. Since then I have had opportunities of studying them better, and it may therefore not be out of place to give a fresh description. This description is limited to the parts above ground. The rhizoma or underground-stem of these species, like that of the Bambusae, is much branched and twisted; but I am unable to state whether there is any difference in the shape and mode of growth in these two species. From these rhizomas, when fully formed, spring every year a small number of stems, which at first are soft and succulent, unbranched and leafless, but bearing at the nodes large sheaths or spathes, which, while the stems are growing, cover the internodes and overlap each other, giving to the upper portion the appearance of a telescope not quite drawn out. From the axils of these large sheaths spring leaf-bearing branches; and while these develop, the stems harden and become woody. In the case of *Arundinaria spathiflora* the stems last a number of years, and as every year new stems are formed, the clump or cluster of stems, which springs from one rhizoma, gets dense, often containing more than 100 stems. The clumps or clusters of this bamboo stand close together, generally forming extensive thickets, so that adjoining clusters cannot readily be separated. When the stems have attained a certain age, they flower and die after ripening their seeds. I do not maintain that they always flower at a certain age; this probably varies according to circumstances, but this bamboo always flowers over large areas. I have collected flowering specimens in Jaunsar, on the hills between the Tons and Jumna Rivers, at 9,000 feet, in May, 1881, but I have observed the species in flower on several occasions in other places. I am unable to say whether in this species the rhizomes die with the seed-bearing stems. On this as on many other points further observation will be most welcome.

Of *Arundinaria falcata* Munro says that the stems are annual. Royle (Ill. Himal. p. 23) says that the annual stems of the hill-bamboo are yearly beaten down by the fall of snow, which protects its perennial roots from excessive frost. In this passage Royle speaks of a bamboo which grows from 7,500 to 10,000 feet, and which must be *A. spathiflora*, the stems of which, as far as I know, are perennial. *Arundinaria falcata* I have collected in flower and in seed on many occasions; at Chakrata (6,000 feet) in

April, 1881, in the Valley of the Manglad, a tributary of the Sutlej River (6,000 feet) in May, 1881, at Jannsar in September, 1878, and at Kula in October, 1876. I readily believe that in the North-western Himalaya the stems are annual and flower annually, but I have no observations upon the subject.

I now proceed to give a brief account of the characters by which these two species can be best distinguished. *Arundinaria falcata*, Nees: stems 6 feet high; internodes 6-12 inches long, $\frac{1}{2}$-$\frac{1}{3}$ inch diam.; nodes much thickened. Sheaths on young shoots thinly membraneous, glabrous, with apex 4-12 inches long, gradually narrowed into a subulate point. Leaves 3-4 inches long, $\frac{1}{4}$ inch broad, glabrous above, with scattered long soft hairs beneath; midrib prominent; of the numerous longitudinal nerves 3-5 pair more distinct than the others; no transverse veins. Apex of sheath without cilia; ligule small, obtuse. Flower-bearing stems leafless; numerous slender branches in compact half-whorls. Spikelets $\frac{1}{2}$-$\frac{3}{4}$ inches long, with 1-2 fertile and one terminal sterile flower. Flowering glume glabrous, 7-9-nerved. Palea as long as flowering glume, two-keeled, with longitudinal nerves outside the keels; three small fimbriate scales; style 2-fid to the base.

Arundinaria spathiflora, Trinius.—Stems to 30 feet high; internodes 6-15 inches long, $\frac{1}{2}$-$\frac{3}{4}$ inch diam.; nodes not much thickened. Sheaths on young shoots (spathes) glabrous, coriaceous, narrowed abruptly into a distinct linear caducous apex; sheaths without apex 6-8 inches long. Leaves 3-5 inches long, $\frac{1}{3}$-$\frac{1}{2}$ broad, glabrous, with three pairs of prominent longitudinal nerves on either side of midrib; conspicuous transverse veins dividing the area of the leaf into squares; leaf narrowed into a short petiole, which is articulate with sheath. Leaf-bearing sheath 2-3 inches long, coriaceous, with prominent longitudinal nerves, fimbriate with long cilia at apex, persistent after the leaves fall, forming an acute angle with the branch. Flowering stems generally with a few leaves; flowers in long panicles, with elongated drooping branches. Racemes of 2-3 spikelets in the axils of large clasping multinerved leafless sheaths, which are fimbriate at the apex like the leaf-bearing sheaths. Spikelets lax, 1-2 inches long, of 6-8 flowers. Flowering glume hairy outside; palea much shorter than flowering glume, with 1-2 longitudinal nerves between the keels; 2-3 falcate scales; style 3-fid to base, long-plumose.

The bamboo described by Major Madden as *Arundinaria falcata* (Ringal), page 614 of Journal Asiat. Society of Bengal, June 1849, is doubtless A. *spathiflora*, also that mentioned by Dr. Cleghorn as *Arundinaria falcata* and *utilis* from several places in the North-west Himalaya, in his Report upon the Forests of Punjeb, 1884. Munro in his Monograph on Bamboos (1868), quotes Royle and Cleghorn under *A. falcata.* Dr. Stewart, in his Punjeb-plants,

1869, identifies the Ringal of commerce with *Arundinaria falcata*, Nees; and, as already mentioned, I did not on page 562 of my Forest-flora (1879) give a completely correct account of these two interesting Bamboos.

Bonn, 18th July, 1885.

Baron Von Müller, in forwarding the above paper of Dr. Brandis to the Hon. Secretary of the Royal Society of New South Wales, refers to the same in the following words :—"These two species of bamboo had been so often found mixed up in works on Botany, that I deemed it advisable to refer the matter directly to the best authority extant, in order to obtain satisfactory information. I, myself, have first introduced into Australia many living bamboo-species, and probably was the first who encouraged their propagation from seed in many parts of the globe. As they are such beautiful and grateful plants, of which there are about 200 species, the publication of Dr. Brandis' important notes on two of the kinds of *Arundinarias* may appear advisable, so as to direct more attention towards them, especially since *Arundinaria spathiflora* is still dragging itself through many botanical works under the name of *Arundinaria falcata*.

Stone Implements of the Aborigines of Australia and some other countries.

By the Rev. PETER MACPHERSON, M.A.

[*Read before the Royal Society of N.S. W., 4 November, 1885.*]

THE following is a list of the stone implements of aboriginal tribes exhibited to-night by the writer on the table of the Society.

NEW SOUTH WALES.

18 hatchets from the Bogan, the Hunter, the Paterson, the Williams, Lake Macquarie, Tilligerry Creek, and the Coast.
1 chisel from the Coast.
1 knife, Lake Macquarie.
1 sharpening-stone, the Bogan.
1 pounding-stone, the Bogan.
3 water-worn stones, which appear to have been partially wrought for hatchets—two from the Rouchel Brook, near Aberdeen, and one from Taree, on the Manning River.
1 water-worn stone from the channel of the Hunter.

VICTORIA.

1 hatchet, chipped ; neither ground nor polished.
Also some flakes from aboriginal quarries.

TASMANIA.

Number of flakes and chippings.

NEW HEBRIDES.

9 hatchets from Erromanga.

GENERAL REMARKS.

A few remarks may be made on these implements. A select class of four of the hatchets may be picked out as forming very serviceable instruments. They are of close-grained stone, and take on a fine polish. Two of them are of a deep black colour ; the other two are green ; they are from the Bogan, the Hunter, the Williams, and the Coast. The one composed of black material, received by the writer from "Bony, King of Meggala," is perhaps the most complete instrument in the collection ; it is $5\frac{1}{8}$ inches in length, $2\frac{1}{2}$ inches in breadth, and $1\frac{1}{8}$ inch in thickness. It weighs $13\frac{1}{2}$ ounces. One of the greenstone composition is the smallest in the

list of hatchets. It measures $3\frac{1}{4} \times 2\frac{1}{4} \times \frac{7}{8}$ inches. It weighs $5\frac{1}{2}$ ounces. The cutting edge of the implement from the Bogan presents a beautifully elegant curve. It seems not to have been used since it was last ground and polished. These instruments are evidently quite fit for the work of cutting through small branches for making shelters, sharpening stakes for uprights or supports of shelters, for disengaging the bark from knots and angular points of trees in order to make primitive tubs for holding water, for cutting rectangular pieces of bark in order to stretch out opossum skins, and for a variety of purposes, not forgetting the advantage of their combined lightness and sharpness for cutting notches in the bark to facilitate the aboriginal method of climbing trees.

It may be mentioned in a sentence that in sharp cutting edges the stone implement is very far behind as compared with an ordinary iron axe. If the angle subtended by the sides of the latter be set down at about twenty-five degrees, in the case of the sharpest of the stone hatchets the angle rises to sixty or seventy degrees.

A second class may be regarded as including five hatchets of much inferior character as cutting instruments. They come from the Bogan, the Paterson River, Tilligerry Creek, near Port Stephens, and Lake Macquarie. None of them take on so fine a polish as the first class. One is merely roughly ground.

A third class may be formed of the nine remaining hatchets, which are distinguished from the others by their large size. They are from the Paterson, the Williams, and Tilligerry Creek. Fixing handles to these unwieldy instruments must have been attended with difficulty, and numerous dints, abrasions, and scratches are strongly suggestive of the device of driving stone pegs between the handle and the hatchet for the purpose of tightening the handle. Two of these implements are distinguished by being grooved as if for the purpose of facilitating the work of fixing on a handle.

In one case the grooving is very conspicuous, though not so much so in the other. In ancient relics of human workmanship found in Europe stone implements occur which are grooved all round at the middle. These are understood to have been used as sinkers for nets. In the present case, the grooving being much nearer one end than the other, as well as the formed cutting edge, leaves no doubt that they were used as hatchets. Still, as they were both found at Tilligerry Creek, close to Port Stephens, which was much frequented by the aborigines, it is not at all impossible that they might have been also serviceable as sinkers. One of them measures $5\frac{7}{8} \times 3\frac{3}{4} \times 2\frac{1}{4}$ inches, and weighs 2 ℔. 11 oz. The other measures $6\frac{7}{8} \times 4\frac{1}{2} \times 1\frac{3}{4}$ inches, and weighs 3 ℔. $\frac{1}{2}$ oz.

Three of the third or class of large hatchets are distinguished by another peculiarity: they have a piece knocked out of one corner so as to fit to the broad part of the thumb where it spreads out into the hand. They could thus be used without a handle, or

when it came off; and as to the work to be done in this way, there was the process of cutting through the bark of trees, low down, quite close to the ground, and then ripping up the bark as far as the operator could tear it off, to make shelters. But although the convenience described indicates an intention to adjust the instrument to the human hand, still the dints and abrasions also indicate that clumsy and unwieldy as were these implements there was the attempt to fix handles to them, and to tighten these handles by driving in hard pieces of stone at right angles to the handle. The largest of the three measures $6 \times 4 \times 1\frac{5}{8}$ inches, and weighs 2 lb. $7\frac{1}{2}$ oz.

The largest implement in the collection partakes somewhat of the same nature as the three now described; but its size is suggestive of its having been used as a wedge for splitting. It is a most unwieldy instrument, measuring $8\frac{1}{2} \times 5\frac{3}{4} \times 1\frac{1}{4}$ inches, and weighing 4 lb. 7 oz. It was found on the Paterson. There is an appearance about the edge of this instrument which gives the idea of its having been forced through hard wood. The same appearance is very noticeable on the large round-headed hatchet with the deep groove already described.

Another of the large hatchets, of speckled green colour and good cutting edge, may be noticed on account of a fine example which it supplies of the skill of some operator to strike off a large flake. The point of impact is made very plain by the converging rays over a space of 3 inches by 4; moreover, the flaked surface is nearly flat, and so differs from the conchoidal fracture occurring in other cases, and so conspicuous where kerosene shale is concerned.

Before leaving the hatchets, notice may be taken of three specimens of what appear to be half-formed implements for cutting. Two of them were found by the writer in the Rouchel Brook district. They were some hundreds of feet above the level of the brook itself, and, being water-worn, they must have been carried to the place where they were found, near sheltering rocks, such as might well be frequented by aborigines. The farmer occupying this ground had in his possession a remarkably fine specimen of hatchet. It was more finished, in the matter of workmanship, than any of those now exhibited. One of the specimens presents very plain marks of having been operated upon by human hands, though the evidence is not so plain in the other case. The third specimen was picked up by the writer at Taree, on the Manning River. It is a water-worn piece of stone, and was found at some distance from the channel of the river, so that it must have been carried away. That flakes have been designedly chipped off it is plain on inspection, but the instrument seems to have been lost or rejected before it was finished. Along with these three half-finished specimens may be noticed the water-worn flat piece of stone picked up by the writer in the channel of the Hunter. It

is exhibited as showing that many water-worn flat pieces of stone require very little work in the way of grinding and polishing to convert them into aboriginal hatchets.

As regards the remaining implements from New South Wales, there is the chisel, of green-stone, well ground and polished; there is the knife, from Lake Macquarie, broad, and three-sided, like a fragment of a hay-knife. Its greasy appearance may be a true index of the use to which it was applied. There is the sharpening-stone, red in colour, apparently of sandstone formation, and well adapted for its purpose. The effect of rubbing some hard substance systematically upon it is quite evident from the grooved surface on each side of the thin fragment itself. The pounding-stone is also of red colour, and very heavy, being well fitted to pound up seeds or crack bones of large animals for the marrow. These two specimens last noticed are from the Bogan.

Going now across the border, there is the one hatchet from Victoria, about which some remarks may be made. It has all the appearance of having been a water-worn piece of volcanic rock called "blue-stone" commonly in Victoria. It has been skilfully chipped, so that the whole of the smooth surface on one side has been chipped off. The cutting edge has the appearance of having been frequently used, on account of the notches, which tell their own tale. It has also been chipped at the sides so as to form a bedding for a handle. Scratches and dints on the remaining smooth side seem to indicate that pegs of hard stone were used to tighten the handle. It has obviously never been either ground or polished. The chipping, however, must have been very skilfully effected. A false stroke would have either broken the implement in pieces, or have struck off a flake from the wrong side. It was found halfway between Ballarat and Geelong, between the Leigh River and the Moorabool. It has a specific gravity of about two and a half, the same as that of the volcanic rock in the neighbourhood, while a close-grained hatchet found in the same district has a specific gravity of three.

The sharp flakes exhibited from Victoria were picked up by the writer at one of the quarries of the aborigines. The quarry was not a depression formed by the removal of tons of stone. In fact it was a little knoll where very hard flinty and quartzy rock cropped up, and appeared in blocks. The space for a quarter of an acre was more or less covered with thousands of chips broken off the rock.

The Tasmanian chippings were picked up by the writer at a place called Bellerive, opposite Hobart, on the left bank of the Derwent.

The hatchets from the New Hebrides were obtained by the writer at Dillon's Bay in Erromanga. The largest is $6\frac{3}{4} \times 2\frac{1}{4} \times 1\frac{1}{8}$ inches, and weighs 1 lb. 1 oz. The smallest broadens from a point to $2\frac{1}{2}$ inches. The length from the point to the centre of the cutting edge is 3 inches and an eighth. It weighs 6 ounces. The

difference of shape presented by the whole of the hatchets from Erromanga, as compared with the Australian, is very marked. Sharpening and rounding the implements to a point at one end is in decided contrast to the general character of the Australian hatchets. One advantage evidently afforded by the Erromangan shape is in regard to the very practical matter of the handle. When once fastened on in a satisfactory manner, the more the implement was used the more tightly the handle became fastened to the broadening sides of the hatchet.

An inspection of the Australian, the New Hebridean, and the Danish hatchets, proves that there are very marked differences between them all. The style of workmanship and the shape of the Danish instruments are greatly superior to what appears in the others. Indeed, the European implements suggest the idea that the first men who had to turn their hand to forming flint hatchets and other such articles in Denmark must have passed through countries in which they saw axes and various instruments formed of metal.

ANTIQUITY OF THE STONE IMPLEMENTS.

There is a point of enduring interest connected with aboriginal implements of stone to which attention may be turned for a few moments. It is the question—how far do these instruments, in themselves or by reason of association, supply evidence as to the antiquity of the people who used them? Thus some of these relics might be found associated with the remains of extinct animals, as the gigantic wombat, or lion kangaroo, or other animals, in such circumstances as to lead to the conclusion that the aborigines and these animals had in former ages been living during the same time. But, so far as the writer knows, none of the implements now exhibited were found in such a connection as to afford any means of reaching conclusions on the subject. Also, the chemical process which produces *dendrites* has been urged in connection with some European relics as affording evidence of the great age of the implements or objects on which the dendritic process had taken place. Nothing of this kind has been observed in any of the implements exhibited.

Another direction in which evidence of antiquity may be sought is in regard to the depth in the soil at which objects of human workmanship may be found. The Hunter River District has sometimes been referred to as supplying evidence that traces of the presence of an aboriginal race have been found 30 feet below the surface; but the mere depth, apart from other considerations, is in this case of very little significance as proving great antiquity. After a flood some of the flats have been covered for acres with new deposit reaching the uppermost rail of a three-rail fence, or about 4 feet. A farmer near East Maitland, in the

locality called Phœnix Park, has pointed out to the writer a mass of soil 10 feet in thickness all of which had accumulated during the eighteen years between 1857 and 1875. The writer also saw that at one place the deposit of new soil had been so great that a fence having been completely covered out of sight a new one had been put up above it. A little examination of the circumstances brings out plainly before the inquirer the evidence that objects of various kinds might in the course of a few years be buried to great depths. The banks of the Hunter are often steep, and lay bare as much as 30 feet of soil which has been deposited by the river itself. Owing to the windings of the stream an inundation from time to time occasions the forming of a new channel, and the blocking up of an old one. Acres of soil are removed from one place and deposited in another. Also in time of flood, where a tree or a snag has been in the way, eddies have been formed, and these scoop out numerous holes 5 or 6 feet deep; these holes and the old channels are in the course of time filled up, covering over and burying such objects as may have found their way into them.

There is still another agency at work by which stone hatchets might quite easily be buried 50 or 60 feet deep. This was forcibly impressed upon the writer as an intelligent and educated settler accompanied him from Tilligerry Creek, near Raymond Terrace, to Port Stephens, and explained what he had witnessed during previous years. For about 2 miles the ride was over successive waves of sand-hills, on which, however, scrub was growing and trees of a very rotten-wooded species of eucalyptus. At one place the settler pointed out where a great wave of sand, presenting a rather steep front and 60 feet in height was steadily invading a secluded marsh. By the constant action of the wind the sand wave had encroached by the space of 20 yards on the level space in the course of nine years. Now, this whole district was much frequented by aborigines. Some of the more remarkable of the stone implements now exhibited were obtained from the settler at Tilligerry Creek, who accompanied the writer on this expedition. If, then, in the days of Captain Cook, a stone hatchet had been dropped at the base of the wall of moving sand described above it would now be upwards of 200 yards away, and 60 feet deep in the heart of the great-sand drift extending for some miles back from the ocean. Thus a man sinking a pit or well in such drift, and finding a hatchet 60 feet deep, might claim 100,000 years for its antiquity, while 100 would be nearer the correct figure for the duration of time required to explain the discovery.

For phenomena of the same kind we have only to visit some of the suburbs of Sydney. Bourke-street and Dowling-street run into a sand dune, out in the direction of Botany. Not long ago the roof of a cottage was to be seen sticking out of this sand dune. The writer has often stepped off the sand on to the shingles of the

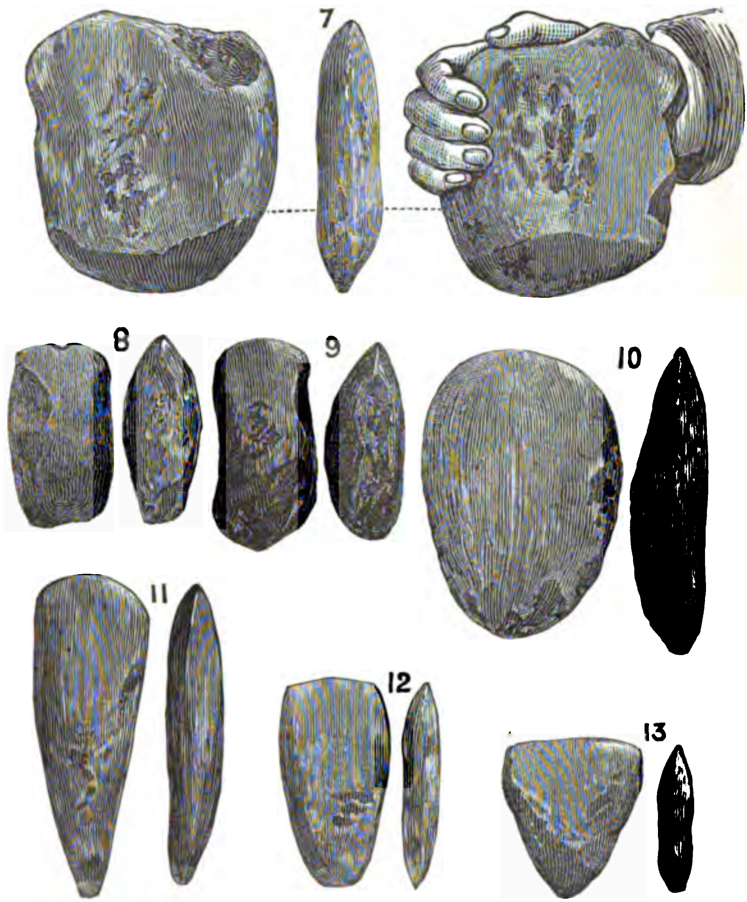
roof of the buried habitation. Some out-houses were completely buried under sand drift to a depth of 10 or 12 feet. The writer ascertained that the cottage had been actually inhabited three years before. The cottage has now disappeared, very large quantities of the sand dune being carted away every day.

While dealing with materials of this kind perhaps another experience may be recorded. It was that of a miner. He was a sedate and devout Highlander, and his tale is very simple. He had penetrated for some yards through surface accumulation when he came to gravel; there, to his amazement, some 10 or 12 feet down, and apparently in a place where the soil had been undisturbed since the geological epoch at which it was deposited, he found—not a hatchet with dendrites upon it, not a half-fossilized boomerang, but a genuine, a veritable pipe—the clay pipe of commerce used for smoking. Now, for a moment, this might seem very perplexing, but only for a moment. For if the floods in the Hunter have been teaching us what may happen in the way of rapidly burying objects to great depths, so also the droughts have been supplying evidence of some strange things that may happen in connection with them. For the explanation of the incident connected with the clay pipe was supplied through certain well-known phenomena attending droughts. The earth cracks right down in thousands of places. The pipe has dropped into one of these cracks and found its way to the gravel, which, naturally enough, formed a break in the continuity of the rent, at least sufficient to intercept an object like a pipe from falling farther. But the drought ends, the rains come, the fissures are completely obliterated, and to all appearance, excepting the clay pipe, the whole soil has lain undisturbed for a geologic epoch. Up to date, direct evidence for a geologic antiquity on behalf of the Australian aborigines seems to be very scanty. Special attention to this subject was directed by Mr. R. Brough Smyth, while making very extensive inquiries from the most competent authorities throughout the Colony of Victoria. After many years of labour in collecting materials, the result is given in words which may be quoted from the work prepared by Mr. Smyth. He says—"It is remarkable that no stone hatchet, chip of basalt, or stone knife has been found anywhere in Victoria, except on the surface of the ground or a few inches beneath the surface." Again he says—"If only small portions of the alluvia in Victoria had been excavated—if the country had not been occupied for twenty years by many thousands of miners who have washed the gravels down to the bed-rock in innumerable shallow gullies—the non-discovery of relics might easily have been accounted for; but in this country the spots most likely to conceal them have been laid bare."—*Aborigines of Victoria*, vol. 1, pp. 364–5.

ABORIGINAL STONE IMPLEMENTS, N.S.W.

1. Stone hatchet. 2. Knife. 3. Chisel.
4. Large hatchet grooved for handle.
5. Very large hatchet or wedge.
6. Sharpening stone.

Scale, 1-4 linear.



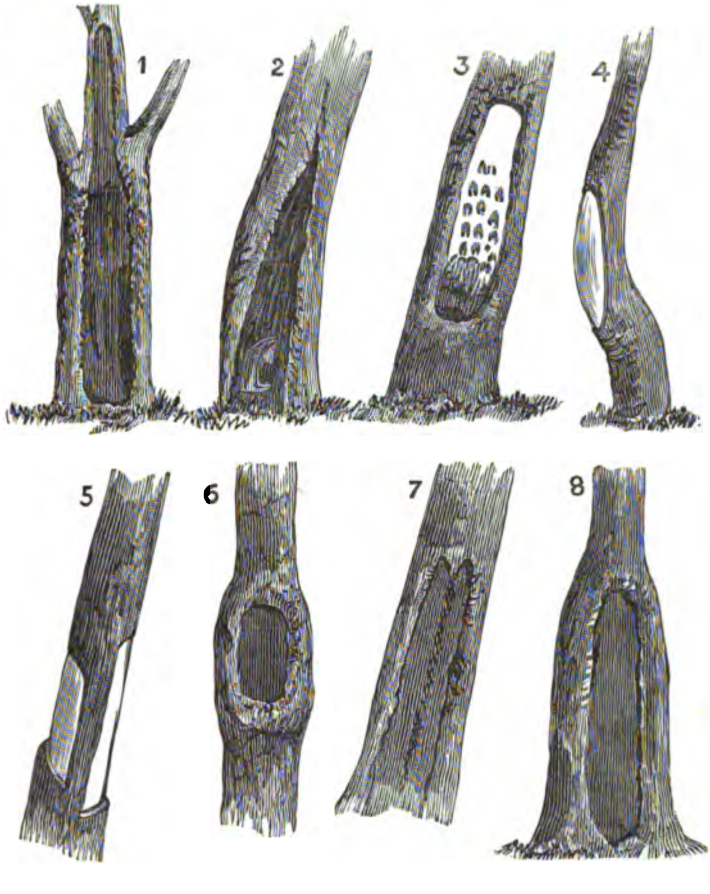
7. Large square hatchet adjusted for hand.

8. Oblong hatchet, very thick.

9. Finely curved edge. 10. Oval shape.

NEW HEBRIDES, DILLON'S BAY.—Nos. 11, 12, 13.

Scale, 1-4 linear.



1. Bark cut with stone hatchet and torn upwards. 1-60 linear.
2. Cutting into trunk of tree for opossum. 1–60.
3. Bark removed in pursuit of caterpillars. 1–40.
4. Hollow piece of bark cut off for holding water. 1–40.
5. Bark cut off for pegging boards. 6. Effect on tree. 1–30.
7. Bark cut off for making shelters. 8. Effect on tree. 1–40.

Notes on experiments in mounting the *Amphipleura pellucida* in media having a higher refractive index than Canada balsam.

By William Morris, Fel. Fac. Phys. and Surg. Glas., F.R.M.S. Lond.

[*Read before the Royal Society of N.S.W., 4 November, 1885.*]

I wish to ask your attention to-night in order that I may give you my experience with mounting diatoms in some highly refractive media.

As a preliminary, I may mention to you that all my experiments have been made on the English test diatom *Amphipleura pellucida*, a very rare diatom, so much so that when in England in 1882, on applying to several opticians and diatom mounters for a small quantity I found it a scarce commodity—it was not obtainable for love or money. Wheeler was the only man who had any, and he told me it was his bread and cheese, therefore could not part with it, as he did not know where he could get a further supply.

My London friends advised me to apply to a gentleman in Dundee, a collector of diatomaceæ. This gentleman I found, but he could not give me any, and recommended me to another gentleman living near Aberdeen. This gentleman I wrote to; he was sorry he could not meet with my requirements, only not to disappoint me he sent as much as would mount two or three slides, making the excuse that in the pool of water they usually grew in, either from the severity of the previous two winters' frosts or something else, no fresh crops had grown for two seasons, and he was unable to afford me any information where I might obtain a supply.

One day whilst sight-seeing on the top of a high timbered hill in Stirlingshire, Scotland, I met a girl carrying a pail of water; I asked her where she got the water, she said—"Doon there, but its nae guid to drink." I followed the path indicated, and this led me to a quarry hole, the edge of which was overgrown with long grass and weeds. This quarry was of whinstone or trap formation, about 20 feet in diameter and containing in depth about 2 feet of water. On fishing up a piece of decayed whin bush, I found it covered over with slime, a clear greenish jelly. On putting a small quantity of it under the microscope (I always carried a microscope with me in my rambles), to my infinite joy there were the *A. pellucida*

swimming along with a *Pinnularia* in company. I secured as much as I could conveniently carry, and on getting back to the hotel I thought I was doing a good thing in getting it carefully dried in a stove. On sending a sample to a friend to prepare a few slides for me in order that I might get it tested with a standard specimen, he told me that the *A. pellucida* were in abundance, but the valves were so broken up from the severity of the manipulation he required to subject the material I sent, that if I gave him the information where to find it he would make arrangements to get a fresh supply and prepare some slides from the wet material. I immediately sketched a rough plan of the locality; at the same time bound him down to keep the place a secret, as I knew if this place was once known to the diatom hunters, they would rush from all parts of Great Britain to obtain a supply, and probably in twelve months time no more *A. pellucida* would be found in that pool. In due course I received the slides and got the *A. pellucida* tested with a standard specimen, and the opinion given was that the striæ were more delicate and numerous than on the standard specimen.

During the fourteen months I was away from this Colony, every lake, stream, or waterhole which I came across was subjected to a micro-examination for diatoms, and it was only in Scotland and America that I found the *A. pellucida*. It is simply that I have had an abundant supply of this diatom that I have been able to carry on and verify the experiments which I am about to relate to you this evening.

In the early part of 1881 I mounted three slides of the *A. pellucida* in phosphorus. Originally the slides were sent out to this Colony as test slides, mounted by Wheeler. On examination the diatoms were found to be fixed on the slide instead of the cover-glass, consequently perfectly useless for hom. lenses. I took the cover off and remounted them in phosphorus. In using this medium it is immaterial whether the diatoms are on the cover-glass or on the slide. The remounts were a success, and I believe the owners of them are satisfied with their perfectness to this day. During the whole of my travels I did not see anything to be compared to the phosphorous mounts which I had left behind.

About twelve months ago, on getting my Spencer $\frac{1}{16}$ hom. lense from America, Dr. Chase kindly sent me a slide mounted by Prof. Smith, of Geneva, America, in his high refractive media 2·4. I can assure you I was surprised at the resolution of the *A. pellucida* in this medium, as up to that date I considered my phosphorus mounts second to none in the world. And now you have the secret why I have been experimenting ever since. Dr. Chase states the difficulty he and Prof. Smith have to contend with is in the ringing, as his medium attacks the cement and his specimens become spoiled. You will see that, with the exception of

the phosphorus mount, I have entirely discarded the ring process, and when properly prepared will keep for all time. They can be roughly handled and, unless enormous pressure is brought to bear upon the cover-glass, it is almost impossible to fracture them, and what is most important, the moment the medium is cold the slide is fit for use. I am prepared to mount, clean, label, and resolve the *A. pellucida* under five minutes time in one of the high refractive media, and in no part of the world can the same feat be performed at the present time, so far as our micro information is to hand to date. Up to the present time the balsams, Canada, Tolu, and Peru, and styrax or liquor amber, are the principal media used for mounting. The Tolu and Peru require ringing, and after a time granular crystals become deposited on the slide. A few drops of glacial acetic acid will prevent this deposit taking place. Both of these balsams I have discarded in preference to the liquid amber. It contains all the elements necessary for mounting of the other two; it is more easily managed, and by using a little extra heat it becomes as hard as the Canada balsam preparations.

I took a good deal of trouble with this liquid amber preparation, as what is obtainable in our drug stores is very dark; but by dissolving it in alcohol, bleaching in peroxide of hydrogen, then dissolving in alcohol, filtering, and evaporating down to the consistency of honey, or thicker still if required, then dissolving in chloroform and again filtering, all the granulations are got rid of, and I think it is quite as good as what I got from Ghee in Dresden, whose preparations Van Heurck, of Belgium, so strongly recommended.

The two other preparations in use are the biniodide of mercury solution and monobromide of naphthaline; both require ringing. Muller prefers the biniodide to the monobromide; he says on account of its smell, but my experience tells me it is owing to its unstableness as a medium; for mounting diatoms it is far before the watery preparation of the biniodide of mercury, having no action whatever in loosening the diatoms from the cover-glass, whereas the biniodide causes the diatoms to fall off and the preparation often becomes spoiled.

If any liquid medium is required, oil of cassia, bromoform, chinoline, lepidine, aniline are all better than Canada balsam, and they can be utilized as a base for mounting purposes, as their density and refractive index can be increased by dissolving in them a solid medium such as sulphur. The density and refractive index of Canada balsam can be greatly increased by dissolving the sulphur in chloroform or bisulphide of carbon, filtering the solution after having added the Canada balsam, then allowing it to evaporate to the consistency required.

In my investigations I had to contend with several coloured preparations very damaging to the eyesight. There are several

which will allow the heat rays of light to pass through, absorbing the luminous rays, and others again allowing the luminous rays to pass through, intercepting the heat rays. For instance, a beam of rays from an electric light properly focused and passed through a cell filled with a solution of iodine in bisulphide of carbon will immediately set fire to a piece of blotting-paper, whereas by substituting a cell filled with a solution of alum instead of the iodine solution no action takes place whatever. The solution of iodine absorbs the luminous rays, only allowing the heat rays to pass through; the solution of alum intercepts the heat rays, only allowing the luminous rays to pass. This will explain why some media tire the eye and often damage the sight. Over and over again I have had to stop work from this cause alone.

Solution of phosphorus in bi-sulphide of carbon.—In a former article published in the August number of the Journal of the Royal Microscopical Society of London for the year 1882, page 579, you will find a detailed account for the preparation and mounting in phosphorus by me, to which I have very little to add except that I have now got over the difficulty of preventing the separation of what I had always looked upon as a watery element in the bi-sulphide of carbon. This watery element would separate and form round the diatoms, as globules, to use an expressive term drowning them. This I now obviate by subjecting the slide after mounting to the direct rays of thesun according to the intensity of the rays of heat and light the time of exposure varies from a few minutes to half an hour. When a smoky metallic lustre just begins to form on the cover-glass the process must be stopped, the action of the sun's rays converts the ordinary phosphorus into the red amorphous, giving the diatoms a reddish brown tinge when examined under the microscope. Too long an exposure will spoil the mount by converting the whole of the phosphorus in solution to the red amorphous.

Sulphur.—The difficulty to get over in mounting in sulphur is to prevent its crystallization. In my first experiments I employed camphor, about $\frac{1}{400}$ part to the quantity of sulphur; this process proved to be very unsatisfactory, as the sulphur after a few days would become opaque or opalescent, from the formation of minute crystals. I then tried menthol, thymol, and iodine, and a variety of other substances. The thymol is the best and answers fairly well, but still a little haziness is liable to form, and by repeated melting and pressing the diatoms get broken up, and the slides almost become valueless by the time crystallization has been overcome.

Not being satisfied, I again commenced experimenting with the sulphur; and knowing the effect sulphur has upon india-rubber I determined to try what effect india-rubber would have upon sulphur in minute quantities. I tried to get the caoutchine in

Sydney, but failed. Mr. C. Watt kindly made me a small quantity from some crude india-rubber which I supplied him with. After trying again and again I did not get any better results, in fact not so good as from the thymol. I gave it up in despair, determined to abandon the sulphur in future. However, sulphur as a mounting medium, in consequence of its high refractive index, has great attraction; I again went at it; this time I was successful, and this is how I managed it:—I took a piece of stick sulphur about the size of half a small pea, melted it on the end of a glass slip, and having trimmed to a point a wooden lucifer match I dipped it into the caoutchine and then stirred it well into the molten sulphur. I then held the slide over the flame of the spirit lamp, gently tilting the slide to cause the sulphur to flow into position a little out of centre; I then brought the heat up to ignition of the sulphur, the flame was immediately blown out and the upper surface of the edge of the cover-glass gently passed over the surface of the sulphur, skimming off all the burned carbonaceous products which had formed on the surface of the melted sulphur, the cover-glass placed in position, and the air-cells gently tapped out from under the cover-glass; then pressure was applied by pressing down the cover-glass on to the slide between two plane surfaces, keeping up the pressure until the sulphur hardens outside the cover-glass. If hazy or any crystallization form, this is owing to air or gas being still retained under the cover-glass; remelt, tap the air-cells out and press as before. I find that two or three remelts are quite sufficient to get rid of all the air-cells and to make the slide permanent. The secret is that whatever hydro-carbon is used heat must be applied sufficiently to decompose it, and no more hydro-carbon than the exact quantity must be used.

Sulphur and selenium.—The same treatment as for the sulphur, but the selenium is so dirty it is impossible to have a clean mount.

Silver film.—This process, so far as the silver deposit is concerned, I made known to you in November last; the only improvement is in using a solution of liquid ammonia to dissolve any chlorides which may be formed after the silver film has been deposited on the cover-glass; then apply heat until the straw tinge is formed. I am pleased to have the opportunity to show you this evening Dr. A. Y. Moore's, of America, slide sent me in exchange for one of mine. You will see that his process and mine are two distinct methods.

Monobromide of napthaline.—This medium used to serve me in the same way as the solution of phosphorus, the diatoms getting completely spoiled by the globules forming over and around them. By adding 3 grains of salicylate of chinoline to the dram of the monobromide this separation is prevented. I suppose its action is by taking up the moisture which may be held in suspension by

the monobromide. Three different makers' preparation all served me in the same way until I used the salicylate of chinoline; now my preparations are permanent.

Biniodide of mercury, solid.—This consists of a saturated solution of the biniodide in piperine. The piperine is melted in a porcelain capsule; the biniodide is gradually added until the piperine will not take up any more, which is known by the red crystals remaining undissolved in the bottom of the capsule; on cooling, a yellow resinous mass is the product. Place a small portion on the slide, melt it and place the prepared cover-glass in position, gently press out air-cells and superfluous material; when cold wash off with spirit and attach the label. The whole process need not occupy five minutes until the slide is ready to use or put away in the cabinet complete.

The alkaloids and crystalline preparation.—Here we enter upon a field of research the preparations of which are easily managed. As a mounting material the merest tyro in microscopical manipulation may make as perfect a mount as one who has devoted years to the mystery of cements and ringing; in fact, the majority of them require no ringing unless the fanciful microscopist chooses to finish off with a parti or tricolour ring. If required, a ring of common glue and finish off with shellac, is all that is necessary to prevent oil or moisture from getting under the cover-glass.

Piperine.—First and most useful is the piperine, the alkaloid of the common black or white pepper. It can be used by itself, or as a base to prevent crystallization in those media which are intensely crystalline. Take for instance picric acid, easily melted, but on cooling crystallizes immediately. Now picric acid has the property, when in solution, of intercepting the heat rays of light, allowing only the luminous to pass through, therefore I considered if I could manage to get a preparation of this acid incapable of crystallizing a valuable medium would be obtained. By melting the piperine on the slide, adding a few crystals of picric acid, mixing it well together, a medium is the result which I look upon as the best of the alkaloids.

Aloein is another refractory preparation; by treating it in the same way a medium of high refractive index is acquired.

The alkaloids of opium, with few exceptions, are all high class media.

Papaverine and the muriate, codeine, cryptopine, narceine, narcotine, meconidine, meconoiosine, nitrate of furfurine, gnoscopine, thebaine are all good media. Atropine, strychnine, aconitine, veratrine, jalapine, picrotoxine, quinine, cinchonine, cinchonidine, cantharidin, valerianate of quinine, santonin, salicylic acid, chrysophanic acid, pyrogallic acid, resorcin, salicylate of chinoline, and tartrate of chinoline. The whole of these alkaloids are far before Canada balsam as mounting media.

I have experimented on a great many more preparations; the above I consider amongst the best and most permanent. Of those alkaloids soluble in spirit and having a determination to crystallize on cooling, such as santonin; valerianate of quinine is the best base as a non-crystallizable to mix with them; of those soluble in water, as resorcin; salicin is the best alkaloid to prevent crystallization.

For bacteria mounting, quick work, splendid definition, giving immensity of light even to the F. eye piece, I am certain they cannot be surpassed, the bacteria being shown like beads of coral when stained with a red dye. The manipulation of the alkaloids is the same as for the solid biniodide of mercury, and if at any time crystallization should set in, melt and gently press down the cover-glass as before.

To those who attempt to work with the above preparations I must warn them to be careful not to inhale the fumes, as on heating some are volatile and commence subliming before they melt, such as cantharidin, which sublimes at 212°, melts at 410°; others again decompose a little over their melting point, such as narceine, nitrate of furfurine, strychnine; some again decompose after being mounted as iodoform.

I am sorry to say that in my investigations I found that a great many of these alkaloids are very impure and dirty, which does not say much for the commercial morality of the manufacturers, and that the greater number of these preparations would require purifying before they could be used with success.

Since reading the foregoing paper at the Microscopical Section, on the 14th September last, I have been experimenting on the chromates, iodides, bromides, chlorides, and sulphides of various metals.

The chromate of lead has a very high refractive index; according to Brewster its refractive index ranges from 2·50 to 2·97, but the difficulty is to get it in a state that it could be used as a medium. Whilst experimenting with this substance I happened to mix a little chromic acid with the chromate of lead, and on holding the mixture over the flame of a spirit lamp dense red fumes were given off. I at once subjected a prepared cover-glass to the action of the fumes, and on examining the deposit under the microscope the diatoms were surrounded by a yellow liquid, and on mounting the cover-class in piperine the preparation had the appearance as if it had been mounted in a film of silver. On further examination with an oil lens, I found the striæ on the *A. pellucida* were as distinct as if it had been mounted in phosphorus. My next aim was to find out what this agent consisted of. I then sublimed the chromic acid by itself and found the same result, only more intense. This showed me the lead salt had nothing to do with it; and on referring to Miller and Watts' Chemistry I came to the conclusion that the red fumes may be the cause, but the

sesquioxide of chromium was the red brownish deposit which formed in and around the diatoms after mounting; that this volatile principle having been deposited on the cover-glass, a decomposition or reduction took place the moment it came in contact with the organic matter of the mounting material. The effect was the same whether I used orcinol, valerianate of quinine, or piperine, and when the deposit was in excess a burned or charred appearance was given to the organic matter.

Since the above experiments were made I have obtained a small quantity of chloro-chromic acid, a highly volatile liquid, giving off red fumes when exposed to the atmosphere. On using it as a liquid medium it is of no value. On holding a prepared cover-glass over the mouth of the vial containing this liquid a slight watery film is deposited, and on mounting the cover-glass I got the same result that I got from the sublimed chromic acid mixed or by itself. This preparation I look upon as one of the most valuable of the series. By regulating the amount of deposit on the cover-glass the colouration may be given from a deep brown to an almost imperceptible tinge, and if necessary the cover-glass can be taken off and remounted on another slide without damaging the preparation.

Chloride of tin.—In relating the method of manipulating this salt it will suffice for a description of the major part of the others. I had already tried this agent as a liquid medium, and discarded it as of no value.

On placing a small portion on the mica slip and subjecting it to heat, dense fumes mixed with the water of crystallization are given off; and when only a clear liquid is left behind still giving off white fumes, the cover-glass is held in position with a pair of forceps to intercept the fumes, a white deposit is immediately formed, and the moment a sufficient quantity is deposited the cover-glass is withdrawn and held over the heated mica until resublimation takes place, leaving a metalic "scud" on the cover-glass. When mounted in piperine, if properly managed the diatoms will be found lying in a film of chloride of tin, the striæ beautifully defined, of a steel-grey lustre, and around the edge of the valve a golden yellow tinge. I think the definition quite up to the phosphorus mounts. Being a deliquescent salt it must be mounted when hot; if not, moisture will be again absorbed and the slide will be found to be worthless when mounted.

Chloride of lead.—Sublimed in the same way it runs the chloride of tin pretty close, the same steel-grey lustre and the golden yellow tinge surrounding the diatoms. The chloride of lead is not deliquescent, consequently more manageable.

Chloride of antimony, commonly known as the butter of antimony. A drop or two of this preparation is gently evaporated on a mica slip until all moisture has disappeared, then the cover

is applied in the same way as with chloride of tin; resublime and mount as before, salt deliquescent, striæ well defined, but not so pretty as with the tin and lead salts.

On subliming the chloride of antimony with metallic arsenic on to a prepared cover-glass, and then subjecting the cover-glass to chlorine gas, the diatoms are gradually dissolved, sometimes only the central rib left, with the remnants of a fringe-like process projecting from the rib. It matters not how little of the diatom is left, the striæ are still visible. This will explode the theory that because no striæ can be obtained on some old *A. pellucida* mounts they (the striæ) must be dissolved or eaten away.

Chloride of copper.—The copper chloride deposit is not so volatile when resublimed as the former ones, consequently it is liable to leave a dirty deposit on the valves, although the striæ are well defined.

Chloride of sulphur.—This is a reddish-yellow liquid, giving off fumes on exposure to the atmosphere. It is only necessary to take the stopper out and place the prepared cover-glass over the mouth of the vial; in one minute's time a sufficiency is deposited on the cover-glass. Have the piperine already melted on the glass slip, transfer the cover-glass direct from the vial to the melted piperine. On examination this mount will be good, striæ bold and well defined, almost as good as some of the sulphur mounts in fact it is a sulphur mount imbedded in the piperine.

Chloride of zinc.—Prepared and mounted in the same way as the former salts, very deliquescent, not so good as the tin, lead, or antimony, but better than the biniodide of mercury.

Chloride of arsenic is made by depositing the metallic arsenic on to the cover-glass and then subjecting the deposited arsenic to the action of nascent chlorine, generated from common salt and sulphuric acid in a small vial, the cover-glass being placed on the mouth of vial. The striæ are well defined.

Iodide of arsenic.—As this salt is very impure, I dissolved it in bisulphide of carbon. Filter and keep in a stoppered bottle. Allow a few drops of the solution to evaporate on a glass or mica slip. The glass is the safest, as if any of the solution gets between the mica scales and remains unsublimed, when in an unconscious moment this slip may be used for a non-poisonous article, the operator may get, before he is aware of it, more arsenic than he bargained for. On holding the slip over the flame of a spirit lamp fumes are given off and deposited on the cover-glass, as in the former preparations. The deposit is soluble in piperine, and if too much is used a yellow tinge is given to the mount. This gives a splendid definition to the striæ, and it is also of value for mounting bacteria.

Iodide of barium, biniodide of mercury, iodide of cadmium.—These three preparations are very good, and cleaner than when the biniodide is dissolved in the piperine, giving a better definition than the watery preparation of the biniodide.

Iodide of antimony is prepared by intimately mixing the powdered metals iodine and antimony, keeping in a well-corked vial, and when it is required to be used, a small portion of the powdered metals is sublimed off the mica slip on to the cover-glass and mount as before. The above four iodides are not as good as the iodide of arsenic.

Iodide of manganese, iodide of zinc are not so good, but still the definition is very fair.

Iodide of silver.—Formed by first depositing a film of silver as in the silver film process, then heating the cover-glass, and then holding the cover-glass over a cell containing a little iodine; a very small quantity of iodine vapour is sufficient—if too much is used the whole of the film of silver will be dissolved. Heat the cover-glass before mounting.

Bromide of silver.—Prepared in the same way as the iodide, but using the vapour of bromine. These two preparations, with a little manipulation, will rival any of the phosphorus and sulphur mounts.

Iodide of ammonia—This salt is good, but refractory. It is liable to leave a brown stain over the diatoms if the resublimation is not complete; the striæ well defined; the refractive index of the cyrstal is very high.

Iodide of cyanogen.—Made by intimately mixing idoform and cyanide of silver. Put a small quantity in a vial; when heat is applied, white needle-like crystals are deposited in the upper part of the vial; on placing a prepared cover-glass over the mouth of the vial a sufficiency is deposited on the cover-glass; mount as before. The striæ well defined.

Chloride of tellurium.—This preparation, manipulated in the same way as the chloride of tin, is the best medium for showing the *A. pellucida* that I have experimented with. The richness of the colouring is something grand to look at: the beautiful steel-grey striæ bold and well-defined, with the golden-yellow-tinged edge of the valve, makes this the most showy slide that can possibly be exhibited, and in my opinion surpasses Professor Smith's American slide,* the medium of which has a refractive index of 2·4; however, you will be able to judge for yourselves, as it is intended to exhibit them both to-night.

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* Professor Smith's slide shown under a Tolles 1-10th, Powell and Lealand microscope and condenser; the tellurium slide under a Spencer's 1-10th, with a Swift's small working microscope, Powell and Lealand's condenser. All agreed that the tellurium slide was far the best exhibit.

Dichloride and tetrachloride of selenium.—These two chlorides are so very volatile and deliquescent that it is a difficult matter to get a film on the cover-glass, and they require further experimenting with. From the examination of several of the prepared slides, I am inclined to think that these preparations will come out well as soon as the metallic selenium can be prevented from being deposited; it will persist in separating out on the cover-glass, giving a dirty appearance to the slide. The valves, which are clean, are splendidly resolved, giving the steel-grey striæ a yellow-tinged edge.

Chloride of ammonia.—Good, but inclined to be dirty; those valves which are clean are bold and well defined—may be useful to sublime with other preparations.

Chloride of thallium.—This is a very fine medium; instead of the steel-grey a sea-green colour is given to the striæ; with the golden-yellow-tinged edge to the valve, it makes a very pretty exhibit. It has a propensity of causing the piperine to crystallize; this can be got over by using the valerianate of quinine as a substitute for the piperine; I do not think this impairs the resolution, whilst it still keeps up the chromatic appearance; some of the valves are resolved as well as with the tellurium, others again have got a varnished look as if the interspaces between the striæ were filled up, and after careful examination minute cracks may be seen in the thin film covering the diatom, as if the thallium had infiltrated itself between the cover-glass and diatom. Those valves found in this state are not so well resolved, giving a more faint look to the striæ.

Chloride of thallium and chloride of tin.—By mixing these preparations together and subliming as usual, this gets over the difficulty of crystallization with the piperine and also the varnished appearance to the diatom, giving a resolution better than any previous medium. The valves may be seen with the central rib jet black, striæ a greenish steel-grey, hard and crisp, the outer edge either black or yellow-tinged according to the amount of film the diatom is lying in.

Cyanide of thallium.—This salt has the same propensity as the chloride in causing the piperine to crystallize. It has the same chromatic hues, striæ well defined, having the sea-green and yellow edge to valves.

Iodide of thallium.—This salt must be sublimed, and then again resublimed; a sufficient impression is left on the valves, on mounting in the piperine the resolution is as good as the iodide of arsenic.

Nitrous acid.—On holding a prepared cover-glass over the mouth of a test tube whilst the nitrous acid fumes are given off a liquid is deposited on its surface. This on mounting in piperine gives an intense yellow colour to the piperine, and on examination the diatoms will be found to be easily resolved, and the striæ wi be defined better than in monobromide of napthaline.

Metallic tin.—On holding a prepared cover-glass over tin in a molten state, an impression is given to the valves which on mounting in piperine the striæ are as well defined if not better than with the biniodide of mercury.

Metallic lead.—The same as the metallic tin. These two last preparations will prove what little is required to give an impression which may wonderfully increase the resolution of the striæ of delicate diatoms, and in taking the whole of the previous media in consideration, will show how a low-angled homogeneous lens may do the work of a high-angled one.

Disulphide of arsenic with sulphur.—Having experimented on the disulphide by itself, I found that it is very refractory. By adding an equal part of sublimed sulphur, and intimately mixing and gently fusing the mixture; and on subliming it on to a prepared cover-glass, and then remelting the sublimate, a medium is obtained which far excels the sulphur by itself, giving a yellow amber-looking film quite transparent; if not so, must be remelted.

The valves have a greenish-yellow metallic lustre, striæ well and boldly defined. On the outer edge of sublimate some of the valves will be found to have as showy an appearance as the tellurium preparations, and quite as good.

Disulphide of arsenic with biniodide of mercury.—These two preparations intimately mixed, and sublimed and melted as with the sulphur preparation, is almost as good as the preceding one; in the first instance a little of the black sulphide of mercury may be formed, but on remelting the sublimate it entirely disappears.

Trisulphide of antimony.—*Pentasulphide of antimony.*—Both these preparations give a splendid definition, and must be manipulated in the same way as the disulphide of arsenic, viz., subliming and then remelting the sublimate on cover-glass; on examination the valves will be seen with a golden-yellow edge, central rib black; striæ milk-white, hard and crisp, equal to the chlorochromic acid preparations. These two preparations ought to be the best for photographing the valves, as a little over or under correction will give a brown or yellow edge to the valve.

All the preparations which have a film may be mounted in Canada balsam if the operator is inclined to use it. The only drawback is its low refractive index, consequently all valves lying outside of the film have a very shadowy appearance.

This completes my investigations up to the present time, but I feel that I am only on the threshold of this important subject, and to take up the ethyl and methyl preparations of the metals would necessitate laborious chemical work besides microscopical, and I feel that I must leave it to younger and more able hands to go on with.

In conclusion, I wish to impress upon microscopical workers to find out as near as possible the refractive index of the material they are working on, because if the material they are working with has the same refractive index as the medium they are going to mount in, practically speaking nothing can be seen unless it is a stained preparation.

My usual plan is to put a drop of the medium on a glass slip; then a prepared cover-glass is placed in position and examine under the microscope; I then immediately see whether I have a mounting medium of a higher refractive index than the silica of the diatom, which is 1·43; if the diatoms are visible and well defined I go on with it, if not I at once discard it. Over and over again have I looked for the outline of a diatom in some new preparation, none visible, and on taking off the cover and getting rid of the medium the diatoms were still adhering to the cover-glass.

I have come to the conclusion that a great deal of our work with the microscope will have to be done over again, and suitable media found for the mounting of various tissues which require to be examined. There is another matter which I would like to draw the attention of the various micro workers to: it is the use of the freezing microtome. My opinion is based upon a law of nature which cannot be got over, viz., that water when frozen expands; when this expansion takes place a bulging or rupture of the minute cell-walls is bound to take place; when the thawing process sets in the contents of these cell-walls escape, and when the preparation is mounted an abnormal structure is sure to be seen. I contend that the contraction and expansion of any tissue in preparation is abnormal, and will give a false appearance to the object under examination. And in the same way with the stains now in use, the contraction and expansion of the cell-walls by these stains must be enormous. I have a dye that if I allow it to act on a *pus* cell for more than one minute the cell will burst, allowing the contents to escape; whereas if taken in time, no stain that I have ever tried will bring out the nuclei of the *pus* cell more perfect.

The bacteria you will see to-night are stained by this fluid; however, I must confine myself to *A. pellucida*—this paper is not intended to be pathological—and, in conclusion, I hope you will excuse me for travelling beyond my subject.

Notes on the Characters of the Adelong Reefs.

By S. Herbert Cox, F.C.S., F.G.S.

[*Read before the Royal Society of N.S.W., 4 November, 1885.*]

The main object of this paper is to place on record a somewhat interesting feature which can now be observed at the 1,000-feet level of the Great Victoria Mine, at Adelong, and which may eventually be of importance in determining the period during which the gold-bearing reefs of the district were formed.

The Adelong reefs traverse a belt of granite, from 6 to 8 miles wide, along a north and south course—the granite upheaval also having followed a north and south line—and they are most excellent illustrations of true fissure lodes.

The gangue from which the gold is extracted is quartz, but this quartz is distributed somewhat irregularly through soft chloritic rocks, which are themselves portions of the main lodes, and are known locally as channels of country.

These channels are bounded by hard walls of granite, which stand very well indeed, large areas being frequently left open with the support of only a prop or two here and there, and they vary in width from a few inches up to several feet.

The lodes frequently split, and one portion continues on its north and south course, while another branch takes on a little easting, and gradually leaves the main fissure. The reefs vary in their underlay, some heading to the east and others to the west while in other cases they are vertical.

There is a common impression in the district that the difference in underlay is due to the surface features of the ground, and that the lodes always dip under the hills; but although this is apparently true in effect, the formation of the hills themselves has of course exerted no influence on the character of the reefs.

The granites are traversed at places by veins or dykes of diorite and hornblende syenite, which is probably a metamorphosed diorite, and what I have to call attention to is the occurrence of one of these veins at the 1,000-feet level of the Great Victoria Mine. The plan and section attached will illustrate the occurrence of this vein. The lode bifurcates at a short distance to the south of the main shaft; and after the main channel had been driven on for some distance and found to be unpayable, a cross cut was entered to the eastward to intersect the other branch. This cross

cut was driven through a belt of granite, but a vein of syenite *(bb)* was also passed through, as shown in the sketch, and this belt of syenite finished abruptly against the more easterly vein. The vein itself also took a much flatter underlay at this point, and for a short distance, I am informed by Mr. M'Cord, the underground manager, was very rich. This rich patch however extended only 15 feet along the course of the lode, and was but 2 inches in thickness.

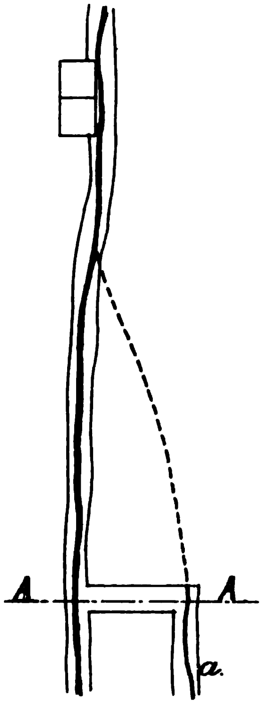
It will be evident from the foregoing notes that this vein of syenite was intruded before the fractures forming the reefs were made, and may thus serve to determine the date of the formation of the reefs; and since other dykes of diorite which have heaved the reefs occur in the district, there will necessarily be two points readily determined concerning them.

[One plan.]

GREAT VICTORIA MINE

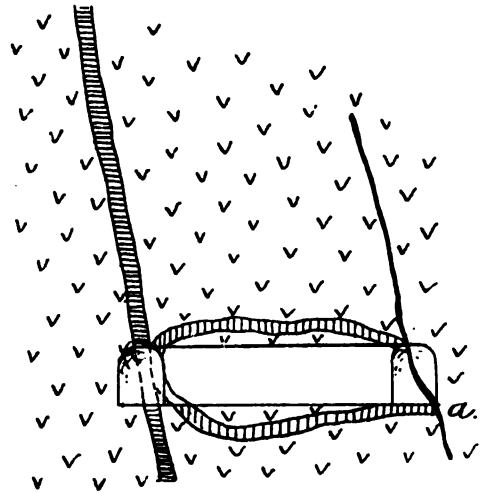
ADELONG

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.



PLAN AT 1000 FT. LEVEL

S. Herbert Cox
16/11/85



ENLARGED SECTION ON AA.

(5h12–85b)

PROCEEDINGS.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

WEDNESDAY, 6 MAY, 1885.

ANNUAL GENERAL MEETING.

H. C. Russell, B.A., President, in the Chair.

The minutes of the preceding meeting held December 3rd, and the special meeting held December 17th, were read and confirmed.

The Annual Report of the Council was then read, as follows :—

"The Council, in presenting its Annual Report, has the pleasure to state that the affairs of the Society show increasing prosperity. The total number of members remains the same as last year. Thirty-four new members were elected during the year, and one name was restored to the roll; the Society lost by death seven members, by resignation four, twenty-one had to be struck off the the roll for the non-payment of the annual subscription (for two years), the election of three new members was cancelled on account of the non-payment of the entrance fee and subscription, making the total number of members on the 30th April, 1885, 494. The vacancies in the list of Honorary Members, caused by the deaths of Sir F. P. Barlee, K.C.M.G., and George Bentham, C.M.G., F.R.S., were filled by the election of Sir George Biddell Airy, K.C.B., F.R.S., and Professor John Tyndall, D.C.L., F.R.S.

"During the past year the Society has received 1,147 volumes and pamphlets as donations; in return the Journal has been presented to 313 kindred Societies and Institutions, as per accompanying list, to which the following names have been added during the year, viz. :—Accademia Nacional de Ciencias Cordoba, Birmingham Philosophical Society, Bureau of Ethnology, Washington; Cincinnati Society of Natural History, Société des Sciences de Finlande, Helsingfors; Société des Sciences, des Arts et des Lettres du Hainaut, Mons, Belgium.

"The Council has subscribed to fifty scientific journals and publications, and has purchased 476 volumes, amongst the most important of which are the following complete series from the commencement :—American Microscopic Journal, three volumes; Journal of Botany, thirteen; Chemical Society—Journal, twenty-eight; Comptes Rendus, eighty-five; Engineer, forty-six;

Engineering, thirty-six; Linnean Society—Journal, Proceedings and Transactions, fifty-three; Notes and Queries, fifty-eight; Science—Journal of, thirteen; Society of Arts—Journal, twenty-five; Tyndall, J.—Works, fourteen; at a cost of £380 13s. 7d.

"Since the last report the following Societies have been written to, soliciting such volumes and parts of their publications as are required to complete the sets now in the Society's Library; and those names marked by an asterisk have either complied with the request of the Council, or promised to do so as far as possible:— *Academy of Natural Science, Philadelphia; Accademia Nacional de Ciencias, Cordoba; American Chemical Society, New York; *Birmingham Philosophical Society; Davenport Academy of Natural Sciences; *Geological Survey of India, Calcutta; Società Geografica Italiana, Rome; Société de l'Industrie Minerale, Saint Etienne.

"Eleven new Societies have during the past year entered into an exchange of publications, viz.:—California State Mining Bureau, San Francisco; Comité Géologique—Institut des Mines, St. Petersburg; Field Naturalists' Club of Victoria; Imperial Observatory of Rio de Janeiro; Manitoba Historical and Scientific Society, Winnipeg; Ministero dei Lavori Publico—Biblioteca e Archivio, Rome; Naturhistorisches Museum der freien Stadt, Hamburg; Naturwissenschaftlicher Verein in Elberfeld; Royal Society of Canada, Ottawa; Société Impériale des Amis des Sciences Naturelles, d'Anthropologie et d'Ethnographie à Moscow, Section d'Anthropologie; Société Royale de Zoologie—Natura Artis Magistra, Amsterdam.

"And the following Societies already on the list have commenced sending their publications, viz.:—Académie Nationale des Sciences, Belles-Lettres et Arts, Bordeaux; Accademia della Scienze dell' Istituto di Bologna; Birmingham and Midland Institute; British Museum; Geological Society, London; Hamilton Association, Canada; Museo Civico di Storia Naturale, Genoa; Naturwissenschaftlicher Verein zu Karlsruhe; Royal Asiatic Society (Straits Branch), Singapore; School of Mines, Columbia College, New York; Société d'Acclimatation de l'Ile Maurice; Société de Biologie, Paris; Société Minéralogique de France, Paris; University of Edinburgh; University of Stockholm; War Department, Washington; Zoological Society of London.

"The Council reports that during the past year the mortgage upon the building has been reduced from £1,100 to £900; the amount subscribed to the Building Fund during the year was £24 14s., and the balance now standing to the credit of the fund in the Bank is £19 19s. 5d.

"The Society's Journal, vol. xvii, for 1883, has been distributed to all members entitled to it; vol. xviii is already in type, and will be published very shortly.

"During the year the Society held eight meetings, including one special meeting, at which twelve papers were read. The Microscopical Section held eight meetings, and the Medical Section five.

"A very successful conversazione was held in the Great Hall of the University on the 8th October last, which was attended by about 900 members and their friends.

"At the Council meeting held on the 11th December, 1884, it was unanimously resolved to award the Clarke Medal for the year 1885 to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., &c.

"In response to the offer of prizes and its medal, by the Society, for communications containing the results of original research or observation upon given subjects, the following were received:—On the origin and mode of occurrence of Gold-bearing Veins, and of the associated Minerals, eight papers; on the Influence of the Australian Climate in producing Modifications of Diseases, nil; on the Infusoria peculiar to Australia, one paper; on the Water Supply in the interior of New South Wales, four papers.

"The Council, at its meeting on the 26th November, 1884, awarded the prize of £25 and the Society's medal, which had been offered for the best communication on the 'Water Supply of the Interior of New South Wales,' to Mr. W. E. Abbott, Abbotsford, Wingen. The papers upon the other subjects were considered of insufficient merit; the Council accordingly was unable to award the other prizes.

"The Council has since issued the following list of subjects, with the offer of the Society's bronze medal and a prize of £25 for each of the best researches, if of sufficient merit:—Series IV.—To be sent in not later than May 1, 1885: No. 13. Anatomy and Life History of the Echidna and Platypus; the Society's medal and £25. No. 14. Anatomy and Life History of Mollusca peculiar to Australia; the Society's medal and £25. No. 15. The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales; the Society's medal and £25. Series V.—To be sent in not later than May 1, 1886; No. 16. On the Chemistry of the Australian Gums and Resins: the Society's medal and £25. No. 17. On the Tin Deposits of New South Wales; the Society's medal and £25. No. 18. On the Iron Ore Deposits of New South Wales; the Society's medal and £25. No. 19. List of the Marine Fauna of Port Jackson, with descriptive notes as to habits, distribution, &c.; the Society's medal and £25. Series VI.—To be sent in not later than May 1, 1887: No. 20. On the Silver Ore Deposits of New South Wales; the Society's medal and £25. No. 21. Origin and mode of occurrence of Gold-bearing Veins and of the associated Minerals; the Society's medal and £25. No. 22. Influence of the Australian Climate in producing Modifications of Diseases;

the Society's medal and £25. No. 23. On the Infusoria peculiar to Australia; the Society's medal and £25."

The following Financial Statement for the year ending 30 April, 1885, was presented by the Honorary Treasurer :—

GENERAL ACCOUNT.

RECEIPTS.

	£ s. d.	£ s. d.
To balance in Union Bank, 30th April, 1884 ...	... ...	49 1 11
,, subscriptions from 1st May, 1884, to 30th April, 1885...	696 6 0	
,, entrance fees	71 8 0	
		767 14 0
,, Parliamentary Grant on subscriptions and entrance fees, from 1st January to 31st December, 1884—£760 4s.—viz., half the amount		380 2 0
,, sale of iron safe	7 10 0	
,, Department of Mines—Freight, &c.	1 3 9	
		8 13 9
		£1,205 11 8

EXPENDITURE.

	£ s. d.	£ s. d.
By advertisements	25 2 0	
,, Assistant Secretary—12 months' salary to 30th April, 1885	200 0 0	
,, ditto—gratuity for extra services	16 13 4	
,, books and periodicals	380 13 7	
,, bookbinding	21 2 4	
,, conversazione—refreshments	50 0 0	
gas, insurance, organ, carpentering ...	11 13 9	
sundry expenses	8 15 0	
,, covering and packing international exchanges	2 4 6	
,, delivering Society's Journal to members ...	4 13 0	
,, engraving illustrations for Society's Journal	4 10 0	
,, freight, cartage, Customs' entries, &c. ...	20 8 0	
,, furniture and effects	52 5 3	
,, gas account	17 6 4	
,, housekeeper, to 30th April, 1885	10 0 0	
,, interest on mortgage (£1,100)...	66 0 0	
,, insurance on building (for £4,000)	5 0 0	
,, insurance on books, furniture, &c. (for £2,500)	2 10 0	
,, postage	36 8 10	
,, petty cash	21 11 2	
,, printing	24 11 0	
,, prize essay award	25 0 0	
,, rates (city, water, and sewerage)	25 14 4	
,, refreshments—general meetings	10 5 0	
,, repairs and improvements to premises ...	13 4 0	
,, stationery	6 12 0	
,, shelving for books	10 18 5	
,, sun-lights in hall	32 2 6	
,, sundries	4 10 3	
		1,109 14 7
Carried forward		£1,109 14 7

EXPENDITURE—*continued.*

	£	s.	d.	£	s.	d.
Brought forward				£1,109	14	7
By transfer to Building Fund Account—						
compositions for life membership	52	10	0			
Parliamentary Grant on same	26	5	0			
				78	15	0
,, balance in Union Bank, 30th April, 1885				17	2	1
				£1,205	11	8

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited—
P. N. TREBECK.
W. G. MURRAY.
Sydney, 1st May, 1885.

BUILDING FUND ACCOUNT.

RECEIPTS.	£	s.	d.	£	s.	d.
To Balance in Union Bank, 30th April, 1884 ...				44	4	11
,, Subscriptions to Building Fund				24	14	0
,, Parliamentary Grant on Subscriptions received, from 1st January to 31st December, 1884, £24 14s.				12	7	0
,, Composition for Life Membership	52	10	0			
,, Parliamentry Grant on same	26	5	0			
Transferred from General Account ...				78	15	0
,, Rent of Rooms from Sundry Societies				59	18	6
				£219	19	5

EXPENDITURE.	£	s.	d.
By Amount paid Savings' Bank of New South Wales in reduction of Mortgage	200	0	0
,, Balance in Union Bank 30th April, 1885	19	19	5
	£219	19	5

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited—
P. N. TREBECK.
W. G. MURRAY.
Sydney, 1st May, 1885.

STATEMENT OF ASSETS AND LIABILITIES ON THE 30TH APRIL, 1885.

ASSETS.	£	s.	d.
To Balance in Union Bank to credit of General Account ...	17	2	1
,, Subscriptions due	98	14	0
,, Rent of Hall, Senate of the University—five months due 30th April, 1885	16	13	4
,, Books and furniture valued at	3,500	0	0
,, Premises in Elizabeth-street—cost of purchase	3,525	0	0
,, Balance in Union Bank to credit of Building Fund ...	19	19	5
	£7,177	8	10

LIABILITIES.	£	s.	d.
By Savings' Bank of New South Wales—Loan on Mortgage...	900	0	0
,, Alexr. Dean—Painting south walls of premises, &c. ...	26	17	0
,, Balance of assets over liabilities	6,250	11	10
	£7,177	8	10

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited—
P. N. TREBECK.
W. G. MURRAY.
Sydney, 1st May, 1885.

CLARKE MEMORIAL FUND ACCOUNT.

1884.		£	s.	d.
March 29—To	Amount at fixed deposit in Oriental Bank Corporation	240	8	11
,,	Interest on £240 8s. 11d. from 29th March to 3rd May, 1884, being from date of deposit to date of suspension, thirty-five days at 6 per cent.	1	7	7
		£241	16	6

H. G. A. WRIGHT, Honorary Treasurer.
W. H. WEBB, Assistant Secretary.

Audited—
P. N. TREBECK.
W. G. MURRAY.
Sydney, 1st May, 1885.

The statement was adopted.

Mr. F. J. Thomas and the Rev. W. Wyatt Gill were elected Scrutineers for the election of officers and members of Council.

A ballot was then taken, and the following gentlemen were duly elected officers and members of Council for the current year:—

HONORARY PRESIDENT:

HIS EXCELLENCY THE RIGHT HON. LORD AUGUSTUS LOFTUS, G.C.B., &c., &c., &c.

PRESIDENT:

PROFESSOR LIVERSIDGE, F.R.S., F.C.S., F.G.S., &c.

VICE-PRESIDENTS:

HON. PROFESSOR SMITH, C.M.G., M.D., M.L.C., &c.
H. G. A. WRIGHT, M.R.C.S.E.

HON TREASURER:

ROBERT HUNT, F.G.S., &c.

HON SECRETARIES:

DR. LEIBIUS, M.A., F.C.S.
W. CAMAC WILKINSON, M.D., M.R.C.P., LOND., M.R.C.S.E.

MEMBERS OF COUNCIL:

CHARLES MOORE, F.L.S.
H. C. RUSSELL, B.A., F.R.A.S.
P. R. PEDLEY.
DR. C. K. MACKELLAR.
CHR. ROLLESTON, C.M.G.
C. S. WILKINSON, F.G.S.

The following gentlemen were duly elected ordinary members of the Society :—

Chadwick Robert, Woollahra.

Morgan, Cosby Wm., M.D., Newcastle.

Park, Archibald John, Hay.

Vernon, Walter N., M.S.A., St. Leonards.

The certificates of three new candidates were read for the second time, and of four for the first time.

The names of the Committee men of the different Sections of the Society were announced, viz. :—

Microscopical Section.—Chairman : P. R. Pedley. Secretary : F. B. Kyngdon. Committee: Dr. Morris, H. G. A. Wright, M.R.C.S.E., G. D. Hirst, and R. Fraser.

Medical Section.—Chairman : Dr. Mackellar. Secretaries : Thomas Evans, M.R.C.S.E., Dr. Hurst. Committee : Dr. Oram, Dr. F. N. Manning, Dr. MacLaurin, Dr. Chambers, Professor Anderson Stuart, M.D., and Dr. Knaggs.

Four hundred and sixty-one donations of books, periodicals, &c., were laid upon the table.

Mr. H. G. H. Wright, M.R.C.S.E., presented to the Society a valuable binocular microscope, by Ross of London, and Mr. H. Sharp, of Adelong, three accessories for the Society's microscope.

The donations were duly acknowledged.

The following letters were read, from Sir George Biddell Airy, K.C.B., F.R.S., and Professor John Tyndall, D.C.L., F.R.S., acknowledging their election as honorary members of the Society; from Sir Joseph Dalton Hooker, K.C.S.I., F.R.S., acknowledging the award of the Clarke Memorial Medal for 1885 ; and from the President of the Comité International Permanent Ornithologique, Vienna :—

The White House, Greenwich, London, S.E.,
16 February, 1885.

Sir,

I am honored and gratified by receipt of your letter of December 5, (which reached me three days past), acquainting me that the Council of the Royal Society of New South Wales had elected me as an honorary member of that Society.

I accept with much pleasure this mark of the friendly estimation by the Society of the scientific efforts which my position has enabled me to make. I have valued much the slight personal acquaintance which I have been able to form with members of the Society, and feel that it is now intensified and extended.

I am, Sir, yours faithfully,
G. B. AIRY.

Archd. Liversidge, Esq.,
Secretary of the Royal Society of New South Wales.

Royal Institution of Great Britain,
3 February, 1885.

My dear Sir,

Might I beg of you to convey to the Council of the Royal Society of New South Wales my best acknowledgments and thanks for the distinction which they have been pleased to confer upon me.

As a proof that friendly feeling exists towards me at the other side of the world, I very highly prize this mark of recognition.

Would you also be pleased yourself to accept my thanks for the friendly manner in which you have communicated to me the intelligence of my election.

Yours very faithfully,
JOHN TYNDALL.

A. Liversidge, Esq., F.R.S.

Royal Gardens, Kew,
February 2nd, 1885.

My dear Mr. Liversidge,

I have the pleasure of acknowledging the receipt of your letter of December 13, together with the "Clarke Memorial Medal," which the Royal Society of New South Wales has done me the rare honor of awarding to me.

This token of the Society's too flattering appreciation of my labours has given me no less surprise than gratification, coming as it does from a Colony in which I have from my boyhood taken the liveliest interest, and from a body of scientific men of the highest distinction.

Nor can I dissociate this honor from the memories it will ever awaken of personal friends of my youth who may be said to have won their scientific laurels in New South Wales itself—Brown, the Cunninghams, Strzlecki, W. Macleay, Mitchell, M'Gillivray, Jukes, Sturt, Lhotskey, Backhouse, Bidwill, Harvey—all explorers of your magnificent flora, from the sea to the Blue Mountains, and beyond it—all contributed materials to those studies of mine which in the concrete are represented in my case by the Clarke Medal.

Nor can I dissociate it from the remembrance of scientific men still living whom I knew in the Colony during my brief visit to it in 1841,—Sir Chas. Nicholson and Dr. Bennett, and who cordially welcomed me to your city, as a young and unknown aspirant for scientific knowledge.

It remains to thank you, sir, for the cordial terms in which you have communicated this award to me, and to beg you to express to the President and Council of the Royal Society of New South Wales my abiding sense of the honor and of the pleasure with which I receive it.

Believe me, dear Mr. Liversidge, very truly yours,
JOS. D. HOOKER.

A. Liversidge, Esq., F.R.S.

Honored Sir, No. 128.

The first International Ornithological Congress, at Vienna, has resolved upon creating an International Permanent Ornithological Committee, whose task it is to establish a net of ornithological observation stations, embracing the whole inhabited world. Extremely difficult as this task appears to be, we, however, think to realize a happy solution, encouraged by the exceedingly kind favours bestowed on us by most of the Governments, and relying upon the mighty protection of science at heart, will energetically assist the Committee in their assiduous exertions of completing this great work worthy of the working together of all mankind.

We therefore confidently think to do no false step by applying to you with the kind request to look for men in your circles who have the mind and intelligence of undertaking this meritorious task, by regularly observing all the birds of their surrounding countries, referring to their occurrence, trains, hatchings, and ways of life, and sending those observations annually (every first quarter of the calendar year) to the Secretary of the Committee.

Vienna, the 31st October, 1884.

The President, Dr. R. BLASIUS.

The Secretary, Gustavus von Hayek, Ph. D.

To the President of the Royal Society of New South Wales in Sydney.

Mr. H. C. Russell, B.A., President, then read his address.

Remarks were made by Messrs. C. Rolleston, C.M.G.; J. Henry, Mr. Justice Windeyer, W. G. Murray, C. S. Wilkinson, and Professor Liversidge.

A vote of thanks was passed to the retiring President, and Professor Liversidge, F.R.S., &c., was installed as President for the ensuing year.

About fifty members were present.

WEDNESDAY, 3 JUNE, 1885.

Professor Liversidge, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Dalton, James Neale, Sydney.
Newbery, William, M.A. (Cantab), Sydney.
Rolleston, John C., C.E., Sydney.

The certificates of four new candidates were read for the second time, and of three for the first time.

One hundred and seventy-two donations were laid upon the table.

Mr. G. H. Knibbs read a paper on "A System of accurate Measurement by means of long steel Ribands."

Mr. Lawrence Hargrave read a paper "Notes on Flying-machines." Sixteen models were exhibited.

About forty members were present.

WEDNESDAY, 1 JULY, 1885.

Professor Liversidge, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Dean, Henry, C.E., Gladesville.
Lendenfeld, Dr. R. von, North Shore.
Marks, James Surfleet, Sydney.
Munro, Andrew Watson, M.B., C.M., Sydney.

The certificates of three new candidates were read for the second time, and of four for the first time.

Seventy-five donations were laid upon the table.

Mr. H. C. Russell, B.A., F.R.A.S., &c., read a paper on "Local variations and vibrations of the earth's surface."

Some remarks were made by the Chairman.

About thirty members were present.

WEDNESDAY, 5 AUGUST, 1885.

Professor LIVERSIDGE, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Goggs, Robert G., M.A. (Cantab), Sydney.
Griffin, Gilderoy Wells (U.S. Consul), Sydney.
Leverrier, Frank, B.A., B.Sc., Waverley.

The certificates of four new candidates were read for the second times, and of seven for the first time.

One hundred and two donations of volumes and pamphlets, and nine charts were laid upon the table.

The Rev. PETER MACPHERSON, M.A., read a paper on "Some causes of the decay of the Australian Forests."

A discussion followed in which the following gentlemen took part, viz.:—Messrs. C. Rolleston, A. Dean, G. Milner Stephen, P. R. Pedley, H. C. Russell, and the President.

Mr. RUSSELL exhibited some photographs of a tree standing a little way off the Lane Cove Road, which measures about 25 feet in circumference, at a height of some 30 feet from the ground. He thought such a rare relic of a past era in the forest growths of Australia should not be lost, and moved that the Government be asked to reserve the portion of ground upon which it stands.

Twenty-two members were present.

WEDNESDAY, 2 SEPTEMBER, 1885.

Professor LIVERSIDGE, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Chisholm, William, M.D. (Lond.), Sydney.
Elsner, F. W., F.R.C.S.I., Sydney.
Ross, Elsey Fairfax, M.D. (Brux.), Sydney.
Roth, Reuter Emerich, M.R.C.S.E., Sydney.

The certificates of seven new candidates were read for the second time, and of three for the first time.

One hundred and twenty-one donations were laid upon the table.

Mr. J. P. JOSEPHSON, A.M.I.C.E., read a paper—"History of Floods in the Hawkesbury River."

A number of chromogenic and pathogenic micro-organisms were exhibited by W. C. WILKINSON, M.D., M.R.C.P., Lond., among which were the following, viz.:—Micrococcus producing intense red colour; Prodigiosus; Zeiss $\frac{1}{12}$, homogenous oil immersion, objective, Dr. Wilkinson's microscope; Micrococcus grown on potato,

causing blue discolouration in milk; Chromogenic micrococcus; Micrococcus tetragonus; Zeiss $\frac{1}{12}$ homegenous oil immersion, objective, Dr. Wilkinson's microscope; Micrococcus Indicus, grown on potato; Chromogenic micrococcus, Society's microscope; Bacillus of cholera, "Koch"; Zeiss $\frac{1}{23}$ water immersion, objective; Bacillus of cholera of domestic hen; Siebert's $\frac{1}{12}$ in. homogenous oil immersion, objective, Mr. Pedley's microscope.

Dr. J. Ashburton Thompson exhibited an advanced copy of a work containing photographs and description of a case of *variola discreta* at the Quarantine Station.

Mr. Henry Sharp, of Adelong, exhibited the following microscopical slides (mounted by himself without pressure):—30 slides, consisting of stained sections of leaves and stems, parasitic insects, and portions of insects mounted without pressure; slide mounted in biniodide of mercury and glycerine; lobes of proboscis of blowfly, Swift's 1-in. objective, Mr. Hirst's microscope; leaf of scented verbena, top side stained, showing oil gland, Powell & Lealand's $\frac{1}{2}$-in. objective, angle, 36°, Dr. Wright's microscope, presented to Royal Society.

About twenty-five Members were present.

WEDNESDAY, 7 OCTOBER, 1885.

Professor Liversidge, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Allworth, Joseph Witter, Maitland.
Baass, James Ranson, Sydney.
Miller, Wm. Valentine, Petersham.
Trickett, Hon. Wm. Joseph, M.P., Minister of Public Instruction, Sydney.
Watson, P. Fletcher, Sydney.

The certificates of three new candidates were read for the second time, and of one for the first time.

The Chairman drew the attention of the members to the following notice (which was posted in the Hall):—Books urgently wanted:—Transactions of the Royal Society of New South Wales, 1867 to 1875; Journal of the Royal Society of New South Wales, 1876. Members who are willing to contribute any of these volumes, or can give information as to where they can be purchased, are requested to communicate with the Hon. Secretaries."

Seventy-five donations of volumes and pamphlets and one map were laid upon the table.

A letter was read from H. J. McCooey, dated Warren, 6th September, 1885, in which he claimed to be the first discoverer of echidna eggs in New South Wales.

Mr. CHARLES MOORE read a paper "On the Ringal of the North-western Himalaya," by Dr. Brandis (communicated by Baron Ferdinand von Mueller, K.C.M.G.) Specimens of the various bamboos now in this country were kindly exhibited by Mr. Moore (Director of the Botanic Gardens).

Professor LIVERSIDGE exhibited portion of a brick made of fire-clay from a locality of the Waikato River, New Zealand, and explained that the green discolouration was due to the presence of vanadium salts.

Mr. J. GOFF exhibited a collection of Danish flint weapons and implements as follows:—

No. 1. Large axe, i raa Filstand. Found in a Kjæmpehoi paa, Krastrap mark, Norre Jylland.

No. 2. Medium-sized axe, i raa Filstand. Found in a Torremore near Silkeborg, Central Jutland.

No. 3. Small-sized axe, broken. Found in Kjokkenmding, near Grenaa, East Coast of Jutland.

No. 4. Large axe, i Slibet Filstand. Found near Koeskilde Fjord, Norre Sjælland, in a Gravhoi.

No. 5. Medium-sized axe—slibet. Found when excavating for a railway between Randers and Hobro, Jutland, in an old Kjæmpehoi. A large number of beautiful specimens were discovered at the same time, but only Nos. 5 and 6 were secured.

No. 6. Smaller-sized axe. (See No. 5.)

No. 7. Large spear-head
No. 8. Medium spear-head
No. 9. Javelin-head, or arrow-head
} Found near "Stone Restrup," Lumfjorden, North Jutland.

No. 10. Saw. Found in a Gravhoi near the Gudenaa, Tvillum-gaard—Gravhoi.

No. 11. Mr. Goff remarked it was one of the most beautiful specimens of a flint knife or dagger (Dolk) he had ever seen, not even excepting the Old Nordish Museum in Copenhagen. Found while excavating the Odensee Bogensee Bane paa, Fyen.

No. 12. Perforated net-sinker (or slung shot.) Found in a mose (probably formerly a small lake) between Viborg and Silkeborg, central part of Jutland.

No. 13. Large stone hammer; a beautiful specimen. Found in a Gravhoi paa, Heden, near Hjerning, centre of Jutland.

No. 14. A smaller stone hammer (Strids hammer). From Marriager Fjord, near Hadsund.

No. 15. An urn; a beautiful specimen. Found in a Gravhoi paa, Ulstrup (Grev. Ahbfeldt's property). When found it contained calcined remains of bones.

No. 16. Broken hammer. Found in close neighbourhood of No. 15.

The specimens were found between the years 1868 and 1879.

About twenty members were present.

WEDNESDAY, 4 NOVEMBER, 1885.

Professor LIVERSIDGE, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The PRESIDENT then referred to the great loss which the Society had sustained by the death of its late senior Vice-President, the Hon. Professor Smith, M.D., C.M.G., M.L.C. He said :—"I feel that it would not be right for us to proceed to the business of this meeting without reference to the very great loss which the Society has sustained by the death of our senior Vice-President, the Hon. Professor Smith, C.M.G., M.L.C. (Hear, hear.) The notice of any losses which the Society may have sustained is usually postponed until the annual meeting; but in this instance we cannot wait until then before expressing our grief for the loss we have sustained, our appreciation of his life and labours, and our sympathy with Mrs. Smith in her great bereavement. (Hear, hear.) Dr. Smith was one of the oldest remaining members of this Society. He first joined it in 1852, then known as the Australian Philosophical Society. When the Australian Philosophical Society was remodelled and merged into the Philosophical Society of New South Wales, in 1856, Dr. Smith, who had taken an active part in bringing about the change, was elected one of the Hon. Secretaries. He retained this position until 1860, and the earlier records in the minute-books, which we still possess, are in his handwriting, and for nine out of the eleven years that the Society was known as the Philosophical Society he was a member of its Council, the break being occasioned by his absence from the Colony during part of the time. He was also retained as a member of the new Council when the Society's constitution and name were further altered in 1867 to that which it now bears. From that date to the present time he has held office as Vice-president for ten years, and as President for the years 1880 and 1883. Previously to 1879 the Governor was *ex officio* President, so that in many of his years of office as Vice-president he (Professor Smith) was in reality performing the duties of President. (Hear, hear.) In other ways the Society is extremely indebted to its late Vice-president for many services. He was very regular in attendance at the Council, as well as at the general meetings, and took great interest in the Society's work and welfare. During his membership he contributed twelve papers and presidential addresses. On this occasion I do not intend to draw special attention to his great and varied labours in other directions. For many years he was practically the Minister for Education, but without pay; and I am afraid, as is too often the case, people little know how much they are indebted to our late friend. (Hear, hear.) Quiet, unobtrusive, conscientious and faithful workers such as he often fail to meet with a

just recognition of their labours. Only those who have worked with or have been closely associated with our late Vice-president, either in Council, the University, or elsewhere, can fully appreciate and testify to his great honesty of purpose, great judgment, even disposition, tolerance, and uniform courtesy. (Applause.)

Mr. Christopher Rolleston, C.M.G., moved the following resolution :—"The members of the Royal Society desire to place on record their sense of the loss the society has sustained in the death of Professor Smith, for many years a most valuable member of the Council, and one of the most active workers of the Society. And, at the same time, they desire to convey to his widow the expression of their deep sympathy with her in the irreparable loss she has sustained." He said that for some thirty years he had been associated with the late Professor Smith on the Council of that Society, and therefore he could testify to the great interest he always took in doing the active work of the Society, and of the intelligent abilities he brought to bear on the subjects brought before the members of that Society. He was sure every one of them must deeply regret that they would not again see Professor Smith amongst them. He felt confident that they would very cordially concur in that resolution. (Hear, hear.)

Mr. H. D. Russell, B.A., said he felt that it was fitting that he should rise to second the resolution which had now been put before them. It was now just about thirty years since it was his good fortune to become a student of the Sydney University under their lamented Vice-president. Professor Smith was the first man from whom he received that sympathy and encouragement which helped in no small degree to mould his subsequent career, and he had always felt, and he trusted he should feel to the end, a deep sense of obligation to him for that early sympathy—a sympathy in all his work, which had been all through one of the most pleasant experiences in a busy life. After what had been so well said by their President and Mr. Rolleston, he would not detain them with any remarks expressing his own estimate of the deep obligation the Society had always been under for that earnest sympathy, kind encouragement to workers, and continuous effort to forward their interests, which had always marked Professor Smith's intercourse with them, but he must express his entire concurrence in the resolution now before them, and he was sure he was only expressing the feeling of every member of the Society in expressing heartfelt sympathy with his widow in her great bereavement.

The resolution was submitted and carried unanimously

The following gentlemen were duly elected ordinary members of the Society :—

Ellis, Henry A., M.B., Woollahra.
Maher, W. Odillo, M.D. (Queen's University, Ireland) Sydney.
Thompson, John Ashburton, M.D. (Brux.), Sydney.

The certificate of one new candidate was read for the second time, and of three for the first time.

Seventy-three donations were laid upon the table.

Dr. W. MORRIS read a paper—"Notes on experiments in mounting the *Amphipleura pellucida* in media having a higher refractive index than Canada balsam."

The following slides were exhibited to illustrate the paper, viz:—

Amphipleura pellucida mounted in tellurium with Tolles $\frac{1}{10}$ objective on Dr. Morris's microscope.

New media *Amphipleura pellucida* mounted in chloride of tin with Tolles' $\frac{1}{10}$ immersion objective. Powell and Lealands-patent oil-condenser exhibited by Mr. Pedley.

Amphipleura pellucida mounted in phosphorus, with Powell and Lealand's new, wide-angled $1\frac{1}{4}$ immersion (water) objective on stand, by Swift, with Powell and Lealand's patent immersion condenser, exhibited by Dr. Morris.

Amphipleura pellucida, mounted by Dr. Chase, with Spencer's $\frac{1}{16}$ oil immersion objective, and Powell and Lealand's condenser, exhibited by Dr. Wright.

Amphipleura pellucida in balsam, with $\frac{1}{60}$th water immersion objective, by Siebert. Wide-angled achromatic condenser (dry) exhibited by Mr. Hirst.

Spermatozoa in diabetic urine, stained with new dye. Exhibited by Dr. Morris with $\frac{1}{16}$ water immersion objective, and Powell and Lealand's patent immersion condenser.

Mr. G. D. Hirst referred to the great value of Dr. Morris's paper, to the time and trouble it must have taken to prepare, and regretted that more interest was not taken in the Microscopical Section, as shown by the very small attendance at the Monthly Meetings.

Mr. S. HERBERT COX, F.C.S., F.G.S., read a paper—"Notes on the characters of the Adelong reefs."

The Chairman pointed out the importance and need of placing on record, at the time, important facts such as had been noted by Mr. Cox.

The Rev. PETER MACPHERSON, M.A., read a paper—"Stone Implements of the Aborigines of Australia and some other countries," and illustrated the same by a large collection of stone axes, hatchets, &c., which were arranged on the table.

The Hon. Dr. J. M. CREED, M.L.C., exhibited a mill, or pestle and mortar, used by the aboriginals on the Murray River to grind various indigenous seeds for food purposes. The tribe whose members used it was now extinct, and it was found in an old camp about 40 miles from Corowa, on the Billabong Creek. He had received information, and had been promised specimens of mills consisting of two flat stones, which were now in use by the natives

of Central Australia. He presented to the Society the stone pestle and mortar, and expressed a hope that the Society might see its way to establish a representative museum of Australian aboriginal implements.

Mr. H. C. RUSSELL exhibited and explained an improved form of tide-gauge, which he had designed to save expense in the construction of these instruments, and thus to extend their use.

The Chairman invited the attention of members to an exhibit of some Echidna eggs, which had been forwarded from Coonamble by Mr. H. J. M'Cooey.

About forty members were present.

WEDNESDAY, 2 DECEMBER, 1885.

Professor LIVERSIDGE, F.R.S., President, in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentleman was duly elected an ordinary member of the Society :—

Jackson, Rev. H. L., M.A. (Cantab), Sydney.

The certificates of three new candidates were read for the second time, and of two for the first time.

It was resolved that Messrs. W. C. W. Bartels and P. N. Trebeck be appointed Auditors for the current year.

One hundred and eighty-six donations of volumes and pamphlets, and six charts were laid upon the table.

A letter was read from the widow of the late Hon. Professor Smith, C.M.G., M.L.C., referring to the resolution which had been passed at the last General Monthly Meeting :—

The following letter was read from the Hon. the Colonial Secretary :—

Colonial Secretary's Office,
Sydney, 6 November, 1885.

Sir,

Referring to your letter of the 28th of August last, transmitting a resolution of the Royal Society suggesting the reservation of a certain piece of land at North Shore, upon which there is standing a tree of more than usual interest, I am directed to state, for the information of the Royal Society, that the Colonial Secretary regrets the Government do not see their way to entertain the suggestion.

I have &c.,
CRITCHETT WALKER,
Principal Under Secretary.

W. C. Wilkinson, Esq., M.P.,
Honorary Secretary to the Royal Society.

Mr. LAWRENCE HARGRAVE read a paper "On a form of Flying-machine," which was illustrated by a large model of the machine and various diagrams.

Mr. H. C. RUSSELL exhibited a new form of anemometer which he had designed. This machine would cost about £12, and would serve the same purpose as instruments in use which cost about

£50. This great cost has so far limited the use of these instruments to the chief observatory in each of the Australian Colonies. The instrument exhibited costs so little that it will be possible to place them in various parts of the Colony—a most important consideration from a meteorological point of view. The speaker then referred to the hail-storm we had last Monday afternoon. At the Observatory the hailstones were as large as small peas, and he thought that the number of hailstones that fell would average about fifteen to the square foot. Mr. Russell then read several letters from different gentlemen, giving accounts of the storm. Mr. Fletcher Watson forwarded a letter, together with sketches of several pellets of ice, in weight from 2 to 9 ounces. At Hunter's Hill also the hail-storm had been very severe, and ice was actually seen floating on the water, and in one instance ice was piled up beside a house to the height of 4 feet. All the gardens in these places were literally destroyed. These storms are of very great interest, and it is desirable to collect all available information about them. He had received several letters, parts of which he would read; another point was that these storms generally came in the year which is the termination of a drought period, at least that is what the observations seem to indicate. Mr. Wilkinson then asked Mr. Russell if he thought there was any foundation for the reports as to the dryness of the Darling, which he believed was worse than it was forty years ago. Mr. Russell in answering said he expected the question of the Darling would arise, so he had brought a few papers with him on the subject. The speaker's own impression was that the Darling would still be much worse before any flood could possibly fill the holes; for if a flood was to come, it would take seven or eight weeks to fill up the holes and find its way to Wilcannia.

The following extracts from letters were then read:—

Mr. Basil Dickinson says, under date 18th November:—"I first visited the Darling in 1839, and took up a station called Yambecoona, 20 miles below Brewarrina, then called the Fisheries. This was the lowest station on the river for many years after that. When we got there the country was suffering from a long drought, and it was with difficulty we could get water for the cattle on the road from Liverpool Plains to the Darling. That river was then a chain of water-holes from Walgett to Yambecoona, and it did not run until 1841. In 1846, again, the river got very low, and could easily be crossed on horseback in many places. Again, in 1849, 1850, and 1851 we had a terrible drought on the Darling; no grass, no salt-bush, and the river so low that the cattle used to get bogged in it. In 1852 there was abundance of rain on the Darling, and the river con-

tinued running a good stream up to 1855, when I left that district. By that time many other stations had been taken up below ours."

Mr. E. M. M'Kinlay, under date November 19, says:—"On Black Thursday, February 6, 1851, I left Melbourne on a journey to the Darling, and travelled nearly as far up as Wilcannia. After forming the station we had to camp with our horses in the bed of the river, as there was not a bite of grass to be had away from it. The bed of the river was then, and had been for months, quity dry, with the exception of small waterholes at considerable distances from each other, and around these grew a little green herbage, which kept life in our poor horses. At this time the squatters had not been long in occupation, but, to my surprise, they did not seem uneasy about the condition of the country. At a station about 150 miles from Wentworth, on the south-east bank of the river, I saw a spring of cool, clear water running out of a small hollow sapling that had been inserted into the bank."

Mr. D. F. Mackay, under date November 21, says:—"In June, 1865, I travelled down the Darling from Brewarrina to within 50 miles of the junction of the Darling and the Murray. The country was a perfect desert, and we had to feed the cattle in the bed of the river, for there was not a vestige of grass on the plains. The bed of the river was dry for miles in many places—simply a chain of waterholes, some of which were quite salt, especially near Bourke."

Mr. J. S. M'Intosh, under date December 12, says:—"The Darling was low at Wentworth in 1861, but got very low in 1862, and the two steamers "Lady Daly" and "Settler," in trying to get up the river in October, stuck 30 miles above Wentworth, and had to discharge their cargoes; and from that time till February, 1863, the river kept getting lower, until it became perfectly dry, and was a chain of water-holes from Bourke to near Wentworth. In March, 1863, a flood came down, caused by rains in Queensland, and from that time to July, 1864, the river was nearly always a "banker." Our last rain that year was in April, and from that until January, 1866, there was not more than half an inch of rainfall on any part of the Darling from Bourke to Wentworth. The river fell rapidly after July, 1864, and all the winter of 1865 was extremely low, and all the creeks were dry. The cold was very severe—white frosts all the winter—and the fish in the river died, killed, it was supposed, by the cold. In November, 1865, the river was so low at Dunlop, 80 miles below Bourke, that I could jump over it. And at Gundabooka the water was so salt, from the saline springs in the banks of the river, that you could not drink it. In January, 1866, there was a very heavy

local rain, but it did not affect the river much; the rain lasted two days, and from that time we had no rain at Bourke until June 21, 22, and 23, when we had a very heavy fall; but again it did not affect the river much, and by September it was very low, and kept so until February, 1867, when a flood came down from the Queensland rains, and on top of that came our own local rains and the floods in the Macquarie. After that the river fell again, and in 1868 was very low; so low that a boat could not cross the river-bars below Bourke, and at Dunlop there was a bar showing through the water, and I often crossed over there, stepping from stone to stone, in May of that year; we had no rain except a few showers, and the river got lower and lower; all the tributaries in this Colony and Queensland were dry, and it is said that salt was collected on the bottom of one of the dried holes, in the 'Cuttaburra,' a tributary of the Warrego, which has not been done since; and what they call drought now, I call overstocking. In January, 1869, a few showers fell, and in March and April we had fine rain about Bourke, a splendid winter, and the river a 'banker.' In February, 1870, the great wet season began."

Mr. J. F. Heydon, under date November 21, says:—"The river immediately above this town (Wilcannia) has stopped running in several places, and is lower than it has been since the middle of 1876. As, however, a flood cannot reach here for almost two months if rain were to fall now in New England, it is the general opinion that the water will be lower in the Middle Darling than it has ever been seen, and unless heavy rains fall at its source not later than February, there is a prospect of the water supply being insufficient for the stock on the frontages. In 1876, at a point 18 miles above this, the bed of the river was perfectly dry for a quarter of a mile, and in other places the water had ceased running. It is almost in the same state now, and must be worse before the flood can come."

From the foregoing notes, it appears that the Darling was, in 1829, salt and dry in places; 1835, too low for boats to navigate; 1839, a chain of water-holes, and did not run until 1841; 1845, ceased to flow at Wilcannia; 1849, 1850, 1851, quite dry in places; 1852 to 1855, running a good stream; 1862, perfectly dry in places; 1863, floods began in March, and in January, 1864, the highest flood on record, water 2 feet to 3 feet over the main street at Bourke for, some say seven weeks; 1865, a chain of water-holes from Walgett to Wentworth; 1866, quite dry in places, although there was in the Middle Darling in January that year a very heavy storm of rain; 1867, very heavy flood in February; 1868, could step from stone to stone over the river in places; 1869, a wet period began; 1876, it was a chain of water-holes; 1879, very heavy flood began in February; 1881, usual February flood absent, river below summer level nearly all the

year; 1882, very sudden flood from rain-storm in February; 1884, river very low; 1885, October 27, stopped running at Bourke, and now a chain of water-holes from Walgett to Pooncarie.

Those interested in the nineteen years period may find some interesting facts in the foregoing figures. The condition in 1862 reappears in 1881, 1863 in 1882, 1865 in 1884. The great rain-storm of Wilcannia in 1866 has its counterpart in the same district and month in 1885, and so on; and I am waiting to see whether the great flood of 1867 is to be reproduced in 1886; if it is, it will be in accordance with the result of experience, as I pointed out in 1876.

The speaker said he had given a deal of time to the question of the droughts, theoretically considered, and had come to the conclusion that the droughts affected the whole earth at the same time. The President conveyed the thanks of the Society to Mr. Russell for his interesting and valuable communications.

Mr. C. S. Wilkinson, F.G.S., exhibited some specimens of red jasperoid rock, beautifully marked with white quartz veins, which is found in large quantities in the Tamworth and Nundle districts.

About thirty-five members were present.

ADDITIONS

TO THE

LIBRARY OF THE ROYAL SOCIETY OF NEW SOUTH WALES.

DONATIONS—1885.

(The names of the Donors are in *Italics.*)

TRANSACTIONS, JOURNALS, REPORTS, &c.

ABERDEEN :—The Aberdeen University Calendar for the academical year 1885–86. *The University.*

Dun Echt Observatory Publications. Vol. III. *The Earl of Crawford and Balcarres.*

ADELAIDE :—Report of the Progress and Condition of the Botanic Garden and Government Plantations during 1884. *The Government Botanist.*

Meteorological Observations made at the Adelaide Observatory during 1882. *The Observatory.*

Transactions and Proceedings and Report of the Royal Society of South Australia. Vol. VII, 1883–84. *The Society.*

Report of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia for 1884–85. *The Board.*

The Forest Flora of South Australia, by J. E. Brown, F.L.S. Parts V and VI. *The Government Printer.*

The Adelaide University Calendar for the Academical Year 1885. *The University.*

ALBANY (N.Y.) :—65th and 66th Reports of the New York State Library, 1883, 1884.

95th, 96th, and 97th Annual Reports of the Regents of the University of the State of New York, 1882, 1883, 1884.

33rd, 34th, 35th, 36th, and 37th Annual Reports of the State Museum of Natural History, 1880–1884 (inclusive).

Boundaries of the State of New York. Vol. II, 1884. *The Trustees.*

AMSTERDAM :—Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen, Tweede Reeks. Deel. XIX, XX, 1884.

Naam-en Zaakregister Verslagen Afd. Natuurkunde Reeks 2. Deel. I-XX, 1884.

Jaarboek van de Koninklijke Akademie van Wetenschappen, 1883. *The Academy.*

Bijdrajen tot de Dierkunde Aflevering 11e Gedeelte 2e, 1884.
,, 12e ,, 3e, 1885. *Société Royale de Zoologie.*

Revue Coloniale Internationale. Tome I, Nos. 1–6, July–Dec., 1885. *L'Association Coloniale Neerlandaise à Amsterdam.*

AUCKLAND :—Report of the Auckland Institute and Museum for 1879–80, 1881–82, 1882–83, 1884–85. *The Institute.*

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BALLAARAT :—Annual Report of the School of Mines for the years 1883 and 1884. *The School of Mines.*

BALTIMORE (MARYLAND) :—
American Chemical Journal. Vols. VI, No. 5.
" " " " VII, Nos. 2, 3, 4.
American Journal of Mathematics. Vol. VII, No. 2.
American Journal of Philology. Vol. V, No. 3. Whole No. 19.
" " " " VI, " 2, 3. " 22 & 23.
Historical and Political Studies (Third Series). Nos. 1, 8, 11, and 12.
Studies from the Biological Laboratory. Vol. III, No. 4.
The Development and Protection of the Oyster in Maryland, by W. K. Brooks, Ph.D. 1884.
University Circulars, Vol. IV, Nos. 36 and 41.
" " " V, " 42, 43, 44.
The Johns Hopkins University.

BERLIN :—Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin. Nos. 40 to 54. 23 Oct. to 11 Dec., 1884.
" 1 to 39. 8 Jan. to 30 July, 1885.
The Academy.

BIRMINGHAM :—Report of the Council of the Birmingham and Midland Institute for the year 1884. *The Institute.*

BISTRITZ (in Siebenbürgen) :—Jahresbericht der Gewerbeschule zu Bistritz. Part XI. 1884–85. *The Director.*

BOLOGNA :—Accademia delle Scienze dell' Istituto di Bologna. Memorie (Serie IV). Tomo V, Fascicolo 1–4, 1884. *The Academy.*

BONN :—Verhandlungen des Naturhistorischen Vereines der Preussischen Rheinlande und Westphalens in Bonn.
Jahrgrang XLI. Folge 5, Band 1, Halfte 1 and 2. 1884. *The Society.*

BOSTON (MASS.) :—Proceedings of the American Academy of Arts and Sciences. Vol. XI, New Ser.; XIX, Whole Ser. Parts 1 and 2. May, 1883, to May, 1884. *The Academy.*
Memoirs of the Boston Society of Natural History. Vol. III, Nos. 8, 9 and 10. Jan. to May, 1884.
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BREMEN :—Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen. Band VII, Heft 2. *The Society.*

BRISBANE :—Acclimatisation Society of Queensland—
Report of the Council for the year 1884. *The Society.*

BRISTOL :—Proceedings of the Bristol Naturalists' Society—
(New Series.) Vol. III, Part 3. 1881–2.
" " IV, " 1. 1882–3.
" " IV, " 3. 1884–5. *The Society.*

BRUSSELS :—
L'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique—
Annuaire. 1884 et 1885.
Bulletin. (Série 3.) Année 52. Tome VI. 1883.
" (" 3.) " 53. " VII et VIII. 1884.
Jours de Solitude. Octave Pirmez. Edition posthume. 1883.
The Academy.

BRUSSELS—*continued.*
Société Royale Malacologique de Belgique—
Annales. Tome XV. (Second Série), Tome V, Fasc. 1. 1880.
„ „ XVIII. („), „ III. 1883.
„ „ XIX. („), „ IV. 1884.
Procès Verbal Séance. Tome XI. (5 Aug., 1883), to Tome XII (6 Dec., 1884).
„ „ „ XIV. (3 Jan. to 5 July, 1885).
The Society.

CAEN :—
Académie Nationale des Sciences, Arts et Belles-Lettres de Caen—
Mémoires. 1883.
Tables dans les Mémoires. 1754 to 1883 incl. *The Academy.*

CALCUTTA :—Asiatic Society of Bengal—
Centenary Review of the Asiatic Society of Bengal, from 1784–1883.
Journal, Vol. LIII. Part I. Special No. (substitute for Nos. 3 and 4), 1884.
„ „ „ „ II. 1884.
„ „ LIV. „ I. Nos. 1 and 2. 1885.
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Proceedings, Nos. 10 and 11, November and December, 1884.
„ „ 1 to 8, January to August, 1884.
The Society.
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Prof. A. E. Nordenskjold.
Sir William Siemens, F.R.S.
William Spottiswoode, F.R.S.
Print of the Royal Society of London in 1878 (framed).

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EXCHANGES AND PRESENTATIONS

MADE BY THE

ROYAL SOCIETY OF NEW SOUTH WALES,

1885.

The Journal and Proceedings of the Royal Society of N.S.W. for 1884, vol xviii, has been distributed as follows:—

The publications for Europe were sent through Messrs. Trübner & Co., London; those for the United States of America and Canada to the care of Messrs. Wesley & Co., Agents for the Smithsonian Institute; the packages for French Societies and Institutions were forwarded through the Ministère de l'Instruction Publique et des Beaux Arts; and in all other cases, not otherwise provided for, the parcels have been transmitted by book post.

The Smithsonian Institute, Washington, U.S.A., and Messrs. Trübner & Co., 57, Ludgate Hill, London, E.C., have kindly undertaken to receive and forward to Sydney all communications and parcels intended for the Royal Society of New South Wales.

Presentations to the Society are acknowledged by letter, and in the Society's Annual Volume.

* Exchanges of Publications have been received from the Societies and Institutions distinguished by an asterisk.

ARGENTINE REPUBLIC.

1. **Cordoba.**—*Academia Nacional de Ciencias.

AUSTRIA.

2. **Prague.**—*Königlich böhmische Gesellschaft der Wissenschaften.
3. **Trieste.**—*Società Adriatica di Scienze Naturali.
4. **Vienna.**—*Anthropologische Gesellschaft.
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9. „ *K. K. Zoologisch-Botanische Gesellschaft.
10. „ *Œsterreichische Gesellschaft für Meteorologie.

BELGIUM.

11. **Brussels.**—*Académie Royale des Sciences, des Lettres, et des Beaux Arts.
12. „ *Musée Royal d'Histoire Naturelle de Belgique.
13. „ *Observatoire Royal de Bruxelles.
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15. **Liege.**—*Société Géologique de Belgique.
16. „ *Société Royale des Sciences.
17. **Luxembourg.**—*Institut Royale Grand-ducal de Luxembourg.
18. **Mons.**—*Société des Sciences, des Arts et des Lettres du Hainaut.

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19. **Rio de Janeiro.**—*L'Observatoire Impérial do Rio de Janeiro.

DENMARK.

20. **Copenhagen.**—*Société Royale des Antiquaires du Nord.

FRANCE.

21. **Bordeaux.**—*Académie Nationale des Sciences, Belles-Lettres et Arts.
22. **Caen.**—*Académie Nationale des Sciences, Arts et Belles-Lettres.
23. **Dijon.**—*Académie des Sciences, Arts et Bellos-Lettres.
24. **Lille.**—*Société Géologique du Nord.
25. **Montpellier.**—*Académie des Sciences et Lettres.
26. **Paris.**—*Académie des Sciences de l'Institut de France.
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28. „ Ecole Nationale des Mines.
29. „ Ecole Normale Supérieure.
30. „ *Ecole Polytechnique.
31. „ Editor, *Cosmos les Mondes.*
32. „ Editor, *Revue des Cours Scientifiques.*
33. „ Faculté de Médecine de Paris.
34. „ Faculté des Sciences de la Sorbonne.
35. „ Jardin des Plantes.
36. „ *L'Observatoire de Paris.
37. „ *Musée d'Histoire Naturelle.
38. „ *Ministère de l'Instruction Publique et des Beaux Arts.
39. „ Société Botanique.
40. „ *Société d'Anatomie.
41. „ *Société d'Anthropologie de Paris.
42. „ *Société de Biologie.
43. „ Société de Chirurgie de Paris.
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45. „ *Société de Géographie.
46. „ *Société Entomologique de France.
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48. „ Société Météorologique de France.
49. „ *Société Minéralogique de France.
50. „ *Société Philotechnique.
51. „ Société de Physique.
52. „ *Société Zoologique de France.
53. **Saint Etienne.**—*Société de l'Industrie Minérale.
54. **Toulouse.**—*Académie des Sciences Inscriptions et Belles-Lettres.

GERMANY.

55. **Bremen.**—*Naturwissenschaftlicher Verein zu Bremen.
56. **Berlin.**—Deutsche Chemische Gesellschaft.
57. „ *Königlich Preussische Akademie der Wissenschaften.
58. **Bonn.**—*Naturhistorischer Verein der Preussischen Rheinlande und Westphalens in Bonn.
59. **Braunschweig.**—*Verein für Naturwissenschaft zu Braunschweig.

60. **Carlsruhe.**—*Grossherzogliches Polytechnikum zu Carlsruhe.
61. „ *Naturwissenschaftlicher Verein zu Carlsruhe.
62. **Cassel.**—*Verein fur Naturkunde.
63. **Chemnitz.**—*Naturwissenschaftliche Gesellschaft zu Chemnitz.
64. **Dresden.**—*Das Statistische Bureau des Ministeriums des Innern zu Dresden.
65. „ *General-Direction der Königlichen Sammlungen für Kunst und Wissenschaft zu Dresden.
66. „ *Königliches Mineralogische Museum.
67. „ *Öffentliche Bibliothek.
68. „ *Verein für Erdkunde zu Dresden.
69. **Elberfeld.**—*Naturwissenschaftlicher Verein in Elberfeld.
70. **Frankfurt a/M.**—*Senckenbergische Naturforschende Gesellschaft in Frankfurt a/M.
71. **Freiberg (Saxony).**—Die Berg Akademie zu Freiberg.
72. „ *Naturforschende Gesellschaft zu Freiberg.
73. **Görlitz.**—*Naturforschende Gesellschaft in Görlitz.
74. **Göttingen.**—*Königliche Gesellschaft der Wissenschaften in Göttingen.
75. **Halle A.S.**—*Die Kaiserlich Deutsche Leopoldinisch—Carolinische Akademie der Naturforcher zu Halle A.S. (Prussia).
76. **Hamburg.**—*Die Geographische Gesellschaft in Hamburg.
77. „ *Naturhistorisches Museum der freien Stadt Hamburg.
78. „ *Verein für Naturwissenschaftliche Unterhaltung in Hamburg.
79. **Heidelberg.**—*Naturhistorisch Medicinischer Verein Heidelberg.
80. **Jena.**—*Medicinisch Naturwissenschaftliche Gesellschaft.
81. **Königsberg.**—*Die Physikalisch-ökonomische Gesellschaft.
82. **Leipzig (Saxony).**—University Library.
83. **Marburg.**—*Gesellschaft zur Beförderung der gesammten Naturwissenschaften in Marburg.
84. „ *The University.
85. **Metz.**—*Verein für Erdkunde zu Metz.
86. **Mulhouse.**—*Industrial Society.
87. **Munchen.**—*Königlich Baierische Akademie der Wissenschaften in München.
88. **Stuttgart.**—*Königliches Statistisches Landesamt.
89. „ *Verein für Vaterländische Naturkunde in Würtemberg.

GREAT BRITAIN AND THE COLONIES.

90. **Birmingham.**—*Birmingham and Midland Institute.
91. „ *Birmingham Philosophical Society.
92. **Bristol.**—*Bristol Naturalists' Society.
93. **Camborne.**—*Miners' Association of Cornwall and Devon
94. **Cambridge.**—*Philosophical Society.
95. „ *Public Free Library.
96. „ Union Society.
97. „ University Library.

98. **Dudley.**—Dudley and Midland Geological and Scientific Society and Field Club.
99. **Leeds.**—*Conchological Society.
100. „ *Philosophical and Literary Society.
101. „ *Yorkshire College.
102. **Liverpool.**—*Literary and Philosophical Society.
103. **London.**—*Agent-General (two copies).
104. „ *Anthropological Institute of Great Britain and Ireland.
105. „ *British Museum (two copies).
106. „ Chemical Society.
107. „ Colonial Office, Downing-street.
108. „ Editor, *Cassell's Encyclopædia.*
109. „ Entomological Society.
110. „ *Geological Society.
111. „ Institute of Chemistry of Great Britain and Ireland.
112. „ *Institution of Civil Engineers.
113. „ *Institution of Naval Architects.
114. „ Library, South Kensington Museum
115. „ *Linnean Society.
116. „ London Institution.
117. „ *Lords Commissioners of the Admiralty.
118. „ *Lord Lindsay's Observatory.
119. „ *Meteorological Office.
120. „ *Mineralogical Society.
121. „ Museum of Practical Geology.
122. „ Patent Office Library.
123. „ *Pharmaceutical Society of Great Britain.
124. „ *Physical Society, South Kensington Museum.
125. „ *Quekett Microscopical Club.
126. „ *Royal Agricultural Society of England.
127. „ *Royal Asiatic Society of Great Britain and Ireland.
128. „ *Royal Astronomical Society.
129. „ *Royal College of Physicians.
130. „ *Royal College of Surgeons.
131. „ *Royal Colonial Institute.
132. „ *Royal Geographical Society.
133. „ *Royal Historical Society.
134. „ *Royal Institution of Great Britain.
135. „ *Royal Meteorological Society.
136. „ *Royal Microscopical Society.
137. „ *Royal School of Mines.
138. „ *Royal Society.
139. „ Royal Society of Literature.
140. „ *Royal United Service Institution.
141. „ Society of Arts.
142. „ University of London.
143. „ War Office—(Intelligence Branch).
144. „ *Zoological Society.
145. **Manchester.**—*Geological Society.
146. „ *Literary and Philosophical Society.
147. „ *Owens College.
148. **Middlesboro'.**—*Iron and Steel Institute.
149. **Newcastle-upon-Tyne.**—*Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.
150. „ „ *North of England Institute of Mining and Mechanical Engineers.
151. „ „ *Society of Chemical Industry.

152. **Oxford.**—*Ashmolean Library.
153. „ *Bodleian Library.
154. „ *Radcliffe Library.
155. „ *Radcliffe Observatory.

156. **Penzance.**—*Royal Geological Society of Cornwall.

157. **Plymouth.**—*Plymouth Institution, and Devon and Cornwall Natural History Society.

158. **Windsor.**—The Queen's Library.

CAPE OF GOOD HOPE.

159. **Cape Town.**—*South-African Philosophical Society.

DOMINION OF CANADA.

160. **Halifax (Nova Scotia).**—*Nova Scotia Institute of Natural Science.

161. **Hamilton (Canada West).**—*Hamilton Association.

162. **Montreal.**—*Natural History Society of Montreal.

163. **Ottawa.**—*Geological and Natural History Survey of Canada.
164. „ *Royal Society of Canada.
165. „ The Ottawa Literary and Scientific Society.

166. **Toronto.**—*Canadian Institute.

167. **Winnipeg**—*Manitoba Historical and Scientific Society.

INDIA.

168. **Calcutta.**—*Asiatic Society of Bengal.
169. „ *Geological Survey of India.

IRELAND.

170. **Dublin.**—*Royal Dublin Society.
171. „ Royal Geological Society of Ireland.
172. „ *Royal Irish Academy.

MAURITIUS.

173. **Port Louis.**—Royal Society of Arts and Sciences.
174. „ Société d'Acclimatation.

NEW SOUTH WALES.

175. **Sydney.**—Australian Club.
176. „ *Australian Museum.
177. „ *Free Public Library.
178. „ *Linnean Society of New South Wales.
179. „ *Mining Department.
180. „ *Observatory.
181. „ School of Arts.
182. „ Union Club.
183. „ *University.

NEW ZEALAND.

184. **Auckland.**—*Auckland Institute.

185. **Christchurch.**—Philosophical Institute of Canterbury.

186. **Dunedin.**—Otago Institute.

187. **Wellington.**—*Colonial Museum.
188. „ *New Zealand Institute.
189. „ Philosophical Society.

QUEENSLAND.

190. **Brisbane.**—*Acclimatization Society of Queensland.
191. „ *Royal Society of Queensland.

SCOTLAND.

192. **Aberdeen.**—*Dun Echt Observatory, Earl of Crawford and Balcarres.
193. „ *University.
194. **Edinburgh.**—*Editor, *Encyclopædia Britannica*, Messrs. A. and C. Black.
195. „ *Edinburgh Geological Society.
196. „ *Royal Botanic Garden.
197. „ *Royal Observatory.
198. „ *Royal Physical Society.
199. „ *Royal Society.
200. „ *University.
201. **Glasgow.**—*Geological Society of Glasgow.
202. „ *University.

SOUTH AUSTRALIA.

203. **Adelaide.**—*Government Botanist.
204. „ *Government Printer.
205. „ *Observatory.
206. „ *Royal Society of South Australia.
207. „ *Public Library, Museum and Art Gallery of South Australia.
208. „ *University.

TASMANIA.

209. **Hobart.**—*Royal Society of Tasmania.

VICTORIA.

210. **Ballarat.**—*School of Mines and Industries.
211. **Melbourne.**—Eclectic Association.
212. „ *Field Naturalists' Club of Victoria.
213. „ *Government Botanist.
214. „ *Government Statist.
215. „ *Mining Department.
216. „ *Observatory.
217. „ *Public Library.
218. „ *Registrar-General.
219. „ *Royal Society of Victoria.
220. „ *University.
221. „ *Victorian Institute of Surveyors.

HUNGARY.

222. **Bistritz (in Siebenbürgen).**—*Direction der Gewerbeschule.
223. **Zagreb (Agram).**—*Société Archéologique.

ITALY.

224. **Bologna.**—*Accademia delle Scienze dell' Istituto di Bologna.
225. „ Università di Bologna.
226. **Florence.**—*Società Entomologica Italiana.
227. „ *Società Italiana di Antropologia e di Etnologia.
228. „ *Società Africana d'Italia (Sezione Fiorentina).

229. **Genoa.**—*Museo Civico di Storia Naturale.

230. **Milan.**—Reale Istituto Lombardo di Scienze Lettere ed Arti.
231. „ Società Italiana di Scienze Naturali.

232. **Modena.**—*Académie Royale des Sciences, Lettres et Arts de Modène.

233. **Naples.**—*Società Africana d'Italia.
234. „ Società Reale Accademia delle Scienze.
235. „ *Stazione Zoologica (Dr. Dohrn).

236. **Palermo.**—*Accademia Palermitana di Scienze Lettere ed Arti.
237. „ Reale Istituto Tecnico.

238. **Pisa.**—*Società Toscana di Scienze Naturali.

239. **Rome.**—*Accademia Pontificia de'Nuovi Lincei.
240. „ *Biblioteca e Archivio Tecnico (Ministero dei Lavori Pubblico).
241. „ Circolo Geographica d'Italia.
242. „ Osservatorio del Astronomico Collegio Romano.
243. „ *R. Accademia dei Lincei.
244. „ *R. Comitato Geologico Italiano.
245. „ *Società Geografica Italiana.

246. **Siena.**—R. Accademia de Fisiocritici.

247. **Turin.**—Reale Accademia delle Scienze.
248. „ Regio Osservatorio della Regia Università.

249. **Venice.**—*Reale Istituto Veneto di Scienze, Lettere ed Arti.

JAPAN.

250. **Yokohama.**—*Asiatic Society of Japan.

JAVA.

251. **Batavia.**—Kon. Natuurkundige Vereeniging in Nederl Indië.

NETHERLANDS.

252. **Amsterdam.**—*Académie Royale des Sciences.
253. „ *Société Royale de Zoologie—Natura Artis Magistra.

254. **Harlem.**—*Bibliothèque de Musée Teyler.
255. „ *Société Hollandaise des Sciences.

NORWAY.

256. **Bergen.**—*Museum.

257. **Christiania.**—*Kongelige Norske Fredericks Universitet.

RUSSIA.

258. **Helsingfors.**—Sociéte des Sciences de Finlande.

259. **Moscow.**—*Société Impériale des Naturalistes.
260. „ *Société Impériale des Amis des Sciences Naturelles d'Anthropologie et d'Ethnographie à Moscow. (Section d'Anthropologie.)

261. **St. Petersburgh.**—*Academie Impériale des Sciences.
262. „ *Comité Géologique—Institut des Mines.

SPAIN.

263. **Madrid.**—Instituto geographico y Estadistico.

SWEDEN.

264. **Stockholm.**—*Kongliga Svenska Netenskaps-Akademion.
265. „ *Kongliga Universitetet.

SWITZERLAND.

266. **Berne.**—*Société de Géographie de Berne.
267. **Geneva.**—*Institut National Genevois.
268. **Lausanne.**—*Société Vaudoise des Sciences Naturelles.
269. **Neuchatel.**—*Société des Sciences Naturelles.

STRAITS SETTLEMENTS.

270. **Singapore.**—*Royal Asiatic Society.

UNITED STATES OF AMERICA.

271. **Albany.**—*New York State Library, Albany.
272. **Annapolis (Md.)**—Naval Academy.
273. **Baltimore.**—*Johns Hopkins University.
274. **Beloit (Wis.)**—*Chief Geologist.
275. **Boston.**—*American Academy of Arts and Sciences.
276. „ *Boston Society of Natural History.
277. **Buffalo.**—*Buffalo Society of Natural Sciences.
278. **Cambridge.**—*Cambridge Entomological Club.
279. „ *Editor, "*Science.*"
280. „ *Museum of Comparative Zoology, Harvard College.
281. **Chicago.**—Academy of Sciences.
282. **Cincinnati.**—*Cincinnati Society of Natural History.
283. **Coldwater.**—Michigan Library Association.
284. **Davenport (Iowa).**—*Academy of Natural Sciences.
285. **Hoboken (N.J.)**—*Stevens' Institute of Technology.
286. **Iowa City (Iowa).**—*Director Iowa Weather Service.
287. **Minneapolis.**—*Minnesota Academy of Natural Sciences.
288. **Newhaven (Conn.)**—*Connecticut Academy of Arts.
289. **New York.**—*American Chemical Society.
290. „ *American Geographical Society.
291. „ *New York Academy of Sciences.
292. „ *New York Microscopical Society.
293. „ *School of Mines, Columbia College.
294. **Philadelphia.**—*Academy of Natural Science.
295. „ *American Entomological Society.
296. „ *American Philosophical Society.
297. „ *Franklin Institute.
298. „ *Second Geological Survey of Pennsylvania.
299. „ *Zoological Society of Philadelphia.

300. **Salem (Mass.)**—*American Association for the Advancement of Science.
301. „ *Essex Institute.
302. „ *Peabody Academy of Sciences.

303. **St. Louis.**—*Academy of Science.

304. **San Francisco.**—*California State Mining Bureau.

305. **Washington.**—*American Medical Association.
306. „ *Bureau of Education (Department of the Interior).
307. „ *Bureau of Ethnology.
308. „ *Bureau of Navigation (Navy Department).
309. „ *Chief of Engineers (War Department).
310. „ *Chief Signal Officer (War Department).
311. „ *Commissioner of Agriculture.
312. „ *Director of the Mint (Treasury Department).
313. „ *Hydrographic Office.
314. „ *Office of Indian Affairs (Department of the Interior).
315. „ *Ordnance Department.
316. „ *Philosophical Society.
317. „ *Secretary (Department of the Interior).
318. „ *Secretary (Navy Department).
319. „ *Secretary (Treasury Department).
320. „ *Smithsonian Institution.
321. „ *Surgeon-General (U. S. Army).
322. „ *U. S. Coast and Geodetic Survey (Treasury Department).
323. „ *U. S. Geological Survey.
324. „ *U. States National Museum (Department of the Interior).
325. „ United States Patent Office.
326. „ *War Department.

Number of Publications sent to	Great Britain...	... ...	81
„ „	India and the Colonies	...	50
„ „	America ...	... ...	57
„ „	Europe ...	... ...	131
„ „	Editors of Periodicals	...	5
„ „	Asia, &c. ...	... ...	2
	Total	... ...	326

A. LEIBIUS, W. CAMAC WILKINSON, } Hon. Secretaries.

The Society's House, Sydney,
14 *July*, 1885.

PROCEEDINGS OF THE SECTIONS.

(IN ABSTRACT.)

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MICROSCOPICAL SECTION.

Preliminary Meeting, held 13 APRIL, 1885.

Mr. G. D. HIRST in the Chair.

IT was decided to hold the meetings of the Section on the evenings of the second Monday in each month. The following gentlemen were elected office-bearers for the ensuing session:—Chairman: Mr. P. R. PEDLEY. Secretary: Mr. F. B. KYNGDON. Committee: Dr. WRIGHT, Dr. MORRIS, Mr. G. D. HIRST, and Mr. FRASER.

11 MAY, 1885.

Mr. PEDLEY in the Chair.

Dr. MORRIS read a paper on the *Phylloxera vastatrix*, descriptive of the propagation, habits, and the injuries caused by this aphis to the vine. Several remedies were spoken of, and the use of sulphate of iron recommended. Mr. CHARLES MOORE narrated the progress of the pest in the Camden vineyards. Several slides of the insect were shown.

Mr. WHITELEGGE exhibited some preparations of mosses found in the neighbourhood of Sydney.

Mr. WALKER showed three species of an aphis parasitic on the Eucalyptus.

Mr. W. H. LANE presented one of C. Fasoldt's micrometric rulings, from 5,000 to 120,000 lines to the inch, and exhibited a new $\frac{1}{18}$ water immersion objective, by the Bausch & Lomb Optical Co., N. York.

Dr. WRIGHT's valuable gift of the Ross-Zentmeyer binocular microscope, and Mr. HY. SHARPE's presentation of illuminating and polarizing apparatus, were used for the first time.

8 JUNE, 1885.

Mr. PEDLEY in the Chair.

A letter was received from Mr. Hy. Watts, of Collingwood, Victoria, presenting a slide of fossil foraminifera from the miocene deposits of Victoria.

Mr. W. H. Wooster, of Bolwarra, Victoria, wrote asking for an exchange of lists of the N.S.W. polyzoa.

Mr. WALKER called in question the durability of glycerine mounts. Messrs. PEDLEY and HIRST exhibited slides several years old showing no signs of injury.

Mr. WHITELEGGE exhibited a series of slides showing the male and female flowers of the following genera of Cryptogamic plants, viz. : the *Chara* (Stoneworts) ; *Metzgeria* (Liverworts); *Archidium* (Mosses) ; and *Gleichenia* (Ferns).

Dr. MORRIS showed the following organisms, found by him in some sedimentary mud taken from the interior of a Sydney water main, viz. : A bacteria, a recurved sponge spicule and vegetable débris ; also, a slide of the bacillus of typhoid fever, taken from a patient, displayed by means of a new $\frac{1}{8}$ homogenous objective, by Messrs. Powell & Lealand, having a numerical angle of 1·5. This splendid glass is catalogued by the makers at £35.

Dr. WRIGHT exhibited Swift's new microscope lamp, known as the Mayall-Nelson lamp ; also, a double-stained preparation of the bacillus of tubercle, taken from the sputa of a consumptive patient.

Mr. PEDLEY showed a freshwater gathering from a pond in the Botanic Gardens, containing a new species of *Melicerta.*

13 JULY, 1885.

Mr. PEDLEY in the Chair.

Mr. WHITELEGGE exhibited a perfect copy of Baker on the Microscope, published in 1742, and purchased for a small sum at a Sydney bookstall.

Dr. WRIGHT showed a slide, by Beck, London, of the comma bacillus of the cholera ; also, a slide, by Möller, of the diatom *Amphipleura lindheimerii*, and the new camera lucida designed by Schröder and made by Ross, London.

10 AUGUST, 1885.

Mr. PEDLEY in the Chair.

Mr. W. H. LANE exhibited the microtome made by the Bausch and Lomb Optical Co., New York ; also, E. Bausch's new self-centreing turn-table, with an attachment for cutting thin covers, and one of the professional series of objectives made by Wales, America, viz., $\frac{1}{12}$ water immersion 170°.

Dr. WRIGHT exhibited, on behalf of Mr. Henry Sharpe, of Adelong, a parasite of the brush turkey, remarkable for the toothed-combed-like process of the inner sides of the tarsi.

14 SEPTEMBER, 1885.

Mr. PEDLEY in the Chair.

Dr. MORRIS read a paper, entitled "Notes on experiments with highly refractive mounting media," illustrated by mounting several slides at the meeting with piperine and picric acid ; he likewise

showed two slides of diatoms sent him by Dr. Chase, America, one mounted in metallic silver and the other in Smith's media, which, as a slide, was completely spoilt by crystallization.

12 OCTOBER, 1885.

Mr. Pedley in the Chair.

Mr. W. H. Lane presented a copy of the following work—"Pathological Mycology," by Drs. Woodhead & Hare, of Edinburgh.

The new high-angled and immersion condensers purchased for the Society's instruments were exhibited.

Mr. Pedley showed a slide of *A. pellucida* mounted in media, as recommended by Dr. Morris.

16 NOVEMBER, 1885.

Mr. Pedley in the Chair.

Mr. Walker exhibited a new portable microscope, by Baker, London.

Dr. Morris showed a slide of bacillus, taken from the intestines of a foal, a true pathological bacteria producing ulcers $\frac{3}{8}$ in. diameter and eating through the true mucous membrane. This complaint seems to be epidemic throughout the Colony, young foals only being affected, suffering from lassitude and dying from exhaustion.

Dr. Morris exhibited slides of *A. pellucida* mounted in tellurium, thallium, chloride of tin, chloride of tin and chloride of thallium mixed. These media represent further investigations in highly refractive mounting media, and the one last named was considered to excel the tellurium mount which Dr. Morris exhibited at the general meeting of the Society.

14 DECEMBER, 1885.

Mr. Pedley in the Chair.

Dr. Morris, in continuation of his investigation of highly refractive mounting media, illustrated his latest and most successful result by a slide mounted in a mixture of sulphur and disulphide of arsenic, prepared as follows:—Take equal parts of the above mentioned, add a small quantity ($\frac{1}{20}$ of bulk) of biniodide of mercury; fuse on a slip of mica; sublime on the cover-glass; re-melt on the cover-glass; then mount in Canada balsam.

Dr. Wright exhibited several slides of *A. pellucida*, mounted by Dr. H. H. Chase, of Geneva, New York, the latest and most successful of his series being mounted in realgar. This slide was carefully compared with Dr. Morris's latest, and the general opinion was that the Sydney slide was in every way quite equal. Dr. Wright also showed a slide, by Dr. Chase, of a new diatom, *Cestodiscus dubius*, met with however by Dr. Morris in gatherings from the waters of Port Jackson.

MEDICAL SECTION.

The Medical Section of the Royal Society held seven meetings during the Session of 1885 ,under the presidency of Dr. Mackellar.

The interest shown in the work of Section H by the Medical Profession is steadily increasing, the average attendance being twenty-four members per meeting, the largest eq ualling twenty-eight, and the smallest twenty-one.

At these meetings, sixteen papers were read, many verbal communications made, and many interesting pathological specimens exhibited.

During the past year, the Section has to deplore the loss of two of its most esteemed members, Dr. George Fortescue and Dr. Cecil Morgan, the former from typhoid fever, the latter from phthisis.

THOMAS EVANS, M.R.C.S.,
GEORGE HURST, M.B., Lond. } Hon. Secs.

A Contribution to the Study of Heredity.

By F. NORTON MANNING, M.D., Inspector-General of the Insane in New South Wales.

[Read before the Medical Section of the Royal Society of N.S.W., 17 July, 1885.]

SOME time ago I commenced an inquiry into the family and life history of the idiotic and imbecile patients in the Hospital for the Insane at Newcastle, with the view of ascertaining the cause of the malady under which they were suffering, and especially how far hereditary mischief had a share in its production. I was soon met by a difficulty which had not occurred to me, in the impossibility of tracing the relations and friends of a large number of the patients. On searching the records, a very considerable proportion were found to be deserted children, who had been picked up as waifs by the police, and, after a short stay in the Benevolent Asylum or some kindred institution, had been sent to find a permanent home at Newcastle. Not long after the opening of the institution twenty cases were sent in one batch from the Benevolent Asylum, and in no one of these was the address of relatives or friends known. In other instances, it appeared that the children had been sent from home to the Hospital upon the death of the relatives or friends immediately in charge of them, and that other relatives, if such there were, took no interest in them, made no inquiries about them, and did not reply to inquiries concerning them. Out of a total of 220 imbecile and idiot patients on the register in July, 1884 (I am excluding the dements and aged epileptics), the address of friends was known only in 140 cases, or less than two-thirds. As I had to gain such information as I required mainly by correspondence with people probably far from well educated, possibly not over bright in intellect, and certainly subject to all sorts of prejudices and fancies, I soon abandoned the task I had set myself. Baffled in the larger and more comprehensive inquiry, I turned to the cases in which there were two or more of a family afflicted with mental weakness; cases which possess a peculiar interest, as more likely to be constitutional and congenital in origin than accidental.

The result of the inquiries made I now propose to place before you; and I may state at the outset that, though far more from as complete as could be wished, they have involved some labour and trouble, and in some cases necessitated the intelligent and confidential assistance of the police, through the courtesy of Mr. Fosbery, the Inspector-General. From twenty-one families, with a total of eighty-two children—forty-eight males and thirty-four

females—I found under care fifty idiot and imbecile children—twenty-nine males and twenty-one females. Two families had four imbecile children each, four families had three each, and the remaining fifteen had two each, receiving asylum treatment and care, whilst other members of these families, remaining at home, were reported as feeble-minded. I have divided these fifty children into four groups.

The first of these I may dismiss at once with the statement that it contains six individuals—four male and two female—from three families; that all, though under hospital care, are imbecile* in a comparatively slight degree; and that the only information I could obtain was they were the only children of their respective families. No information was obtainable as to the cause of the imbecility, the consanguinity of parents, or the insanity or neurosis of relatives.

In the second group are three children—two boys and a girl—all imbeciles of a low grade. They belong to a family of three boys and five girls—and the mother writes as follows:—"The cause in the first boy was my getting a sunstroke whilst pregnant; the second boy was afflicted through my being thrown from a horse whilst pregnant; and the girl from my helping my husband to fall a tree whilst pregnant. All the other children are sound in intellect. My husband and myself were in no way related, neither of us have been subject to fits, and, as far as I know, none of our people (my husband's relatives or my own) were subject to insanity or weak in mind." The letter is well written, and, apart from the fancies as to causation, strikes one as that of an intelligent woman. Some further inquiries served to establish the fact that no near relatives—that is, either brothers, sisters, father, or mother—of either parent had been insane. Little or nothing was known of the grandparents and uncles and aunts of the parents, and it is possible that hereditary influence might have been ascertained could further information have been obtained. As the matter stands, we have three badly imbecile children in a family of eight; no known—certainly no close—hereditary influence, and no marriage of near kin, and the group is as you will see, in these respects, exceptional.

In the third group are twenty-six children—eleven males and fifteen females—all imbecile or idiotic, and belonging to twelve families, in which, up to this time, the total number of children is forty-four—twenty-five males and nineteen females. Unhappily, some of these families are still increasing; but, so far, we have eleven out of twenty-five males, and fifteen out of nineteen females, so

* I use the term imbecile when the patients can speak, and idiot when they do not possess this power, and are so far lower in the mental scale. The distinction is a useful and practical one. The degree of imbecility or idiocy, of course, varies much in different cases.

far imbecile or idiotic as to need hospital care. Of the mental condition of the children not under care I have no means of judging, but I have information that four are badly deformed, one is a dwarf and is being exhibited as such in a show, and three have supernumerary fingers and toes.

In none of these twelve families, so far as I can learn, are the parents closely related, but in all there are insane relations, more or less close, and in five of them there has been a veritable intermarriage of disease, there being insanity on both sides. In these five families there are eighteen children—ten males and eight females, and twelve of these—four males and eight females—are imbecile and idiotic; so that two-thirds of the total and every female are afflicted, and among them are to be found all the badly idiotic patients in this group. In the seven families in which insanity has been traced only on one side, there are twenty-six children—sixteen males and ten females—and, of these, fourteen—six males and eight females—are imbecile, the proportion being over a half, and the females, as in the other cases, showing a larger proportion than the males.

I have placed all these cases in a tabular form, showing the insane relations in each. Some of these were peculiar, and of special interest.

In case 5, a paternal uncle and the paternal grandmother, and also a maternal uncle, were insane, and two out of the three died in Gladesville. In this case the whole family. four in number, were idiots of a low type, crippled, and unable to walk.

In case 6, the father was insane and deformed, and the mother was epileptic and occasionally insane. The family consists of three children—two females, both imbecile and one deformed, and one male, a dwarf.

In case 8, two maternal uncles were insane and under care at Gladesville; a maternal cousin is an imbecile at Newcastle, and a paternal cousin was in the same institution. Two out of four children are imbecile.

In case 15, the maternal grandmother was for some time at Gladesville; five maternal uncles were incurably insane and under hospital care, and a sixth maternal uncle had been four or five times under treatment for short periods. There are two children only in the family, and both are imbecile.

The peculiar sympathy which people who are neurotic and have a tendency to insanity feel for each other often results in marriage. I have on several occasions had husband and wife under my care at the same time for marked insanity; and the peculiarities of persons who come as visitors to their wives and husbands when patients in hospitals for the insane are most

remarkable, and occasionally lead to the conclusion that the less insane member has been placed under care, and the more insane left at large. Our Chairman will remember a case in which he was asked, with me to give an opinion as to the mental condition of a husband; and in the course of our inquiries we found that two other medical practitioners had been asked some time before to express a like opinion as to the wife; and I can recall more than one similar experience.

I am by no means certain that I have been able to ascertain all the insane relations in these twelve families; indeed, it is highly probable that I have not, for the family tree in this Colony exists, for the most part, only in an undeveloped and shrubby state, and the family annals are little subject to correction by the village gossip or the "oldest inhabitant."

How difficult it is to obtain trustworthy information in these cases may be judged from the fact that, in one case, a mother denied all knowledge of insanity in the family, though four members were under asylum care, and persistently attributed the mental condition of one of her children to fright, caused by a goose flying over its head when fourteen months old.

In the fourth group were fifteen children—thirteen males and two females—from five families, with a total of twenty-four children—fifteen males and nine females. In two cases I was able to ascertain that there was insanity in the family, and in the whole of the cases the parents were closely related. In two instances they were first cousins, and in the remaining three, after patient inquiry made through confidential channels, I obtained convincing evidence that they were, in each instance, brother and sister. In one instance they left England to avoid remark, and accounted for their curious likeness to each other by describing themselves, both on board the ship in which they came to the Colony and subsequently, as first cousins, but of their closer relationship there was no doubt. The father died a short time ago, and the mother is bed-ridden from paralysis. Both are described as dull in intellect.

In the second case, a Magistrate of the Colony writes:—"The man is sober and steady, and the woman who cohabits with him is generally known as his sister. Their mother, now ninety-five years of age, lives with them, and is feeble both in body and mind, the latter possibly from her great age. Besides the three idiot children, there are four others—a son and a daughter who are married, and two unmarried girls. All of these, as well as the parents, are more or less simple, and in the children at home mental weakness is quite visible. Humane persons have, on several occasions, sought to take action as regards the parents, but found the law contained no provision for such cases. They are generally avoided by their neighbours, who hold little intercourse with them."

In the third case, the parents are described as uneducated, and below par in intellect and low type.

With the exception of the woman 95 years of age above mentioned, nothing could be learned as to the grandparents or other relations of the children, nine in number, three belonging to each family, who were the product of sexual intercourse between brother and sister. It is somewhat remarkable that the whole nine were idiots of the lowest type, dirty in habits, unable to utter an articulate sound, and so paralyzed and deformed as to be unable to walk.

In connection with these cases, I may mention that Dr. Bemiss (whose inquiries in this direction are well known, and who published a summary of them in the second volume of the "Transactions of the American Medical Association") obtained particulars of thirty-one children born in the United States of brother and sister, or parent and child, and of these, twenty-nine were defective in one way or another, nineteen were idiotic, one epileptic, five scrofulous, and eleven deformed; and the same inquirer found that of 2,778 children born of first cousins, 793 were defective, 117 deaf and dumb, sixty-three blind, 231 idiotic, twenty-four insane, forty-four epileptic, 189 scrofulous, and nine deformed.

The question of the full proportion of idiocy and imbecility due to hereditary influence is an interesting one. Forty-one of the cases I have mentioned appear to be so due, and I have knowledge of twenty-five other cases in the Hospital at Newcastle in which there is family insanity, making sixty-six cases out of 220, or somewhat less than one-third. If full information could be obtained, I am convinced that almost if not quite half of the cases could be traced to hereditary insanity or mental weakness.

The cases of which I have given particulars go towards proving—

1st. That idiocy, in a large proportion of cases, is not an accident, but is due to hereditary influence, and is the result of the natural laws governing this. Of the certainty of these laws and the importance of their bearing on the facts of human life we have a full conviction, though we are unable exactly to define their processes; and the pathological action of hereditary influence is as difficult and obscure as the physiological action thereof.

2nd. That cases of direct heredity of imbecility or idiocy are fully as common as those in which it is transmitted in the collateral or reversional form, which is opposed to the view of Dr. Seguin, a great authority on this subject, who remarks—"I have not, to my knowledge, ever had to attend an idiotic son of an idiot, or even the son of a man of weak intellect, but I have often found in the family of one of my patients an aunt, or much oftener, a grandfather, afflicted with idiocy, or at least imbecility."

3rd. That double heredity is, as might be expected, much more potent than where the taint exists on one side only.

4th. That whilst there is abundant evidence that the chief varieties of mental malady are themselves transmissible, nervous disorders are often transformed in their transmission, and that the metamorphoses of heredity are perplexing. A family whose head has died insane or epileptic does not of necessity consist of lunatics and epileptics but the children may be idiots, paralytics, or scrofulous. What the father transmits is not insanity, but a vicious constitution, which manifests itself under various forms; or, to quote Dr. Morel*—"We do not mean exclusively by heredity the very complaint of the parents transmitted to the children, with the identical symptoms observed in the progenitors, but the transmission of organic dispositions. Psychologists have frequent occasions for observing this hereditary transmission, and the various transformations which are exhibited in the descendants. A neuropathic state of the parents may produce in the children an organic disposition which will result in mania or melancholy—nervous affections which, in turn, may give rise to more serious degeneracy, and terminate in the idiocy or imbecility of those who form the last link in the chain of hereditary transmission."

5th. That unions between blood relations influence idiocy and imbecility more than they do the acquired forms of insanity, or those which show themselves after childhood.

The fourth group is an interesting one, as tending to raise the question of the influence of consanguineous marriage; but I am inclined to think that the cases in no way militate against the conclusions arrived at by Huth, in his elaborate volume on the marriage of near kin, which may be thus briefly stated :—

Consanguineous marriages, by the mere fact of consanguinity, and irrespective of any inheritance, are not injurious to offspring; and in the marriage of two relatives, both perfectly healthy, and living under healthy conditions, and whose families are perfectly healthy, the children born will probably be healthy.

In addition to the facts stated in proof of this conclusion in Huth's work, I may mention one which has recently come to my knowledge. In 1858 two families named Young, numbering sixteen in all, descended from the mutineers of the "Bounty" and their Otaheetian wives, returned from Norfolk Island to their old home at Pitcairn. The children were all first cousins on their father's side, and their parents were all closely related. In 1863 a further migration of the Young family, with a family named Christian, and one individual named Buffet—in all thirty persons—took place from Norfolk Island to Pitcairn, all these being closely related to each other and to the former swarm. In 1882 the number of inhabitants on Pitcairn had risen from forty-six to 104, the increase being, with two or three exceptions, due to births

* Traité des dégénérescences de l'espèce humaine.

on the island; and Captain Bouverie Clark R.N., who then visited the place and specially examined the children at my request, reported that there was no case of idiocy, imbecility, or weakness of intellect, or deformity among them.

In ordinary life, however, and in ordinary conditions, it is difficult to find persons in perfect health, and with no imperfections, physical or mental, to be transmitted. It is well known that any morbid tendency existing in each parent is transmitted with great certainty, and usually in intensified degree, to the offspring. Relations, of course, must more frequently than strangers, possess the same constitutional condition, and, as has been said, "consanguinity raises heredity to the highest power." It is more than probable that in the cases I have brought under your notice, we have an intermarriage of disease in its worst form. In the cases of incestuous union, all the parents are described as more or less weak-minded; and the very fact of their seeking such unions, in the conditions of life as they now are, is in itself evidence of scant intellectual development and blunted moral feelings.

If I had been able to devote the necessary time to the subject, I should have been glad to discuss the interesting question of the connection between bodily deformity and intellectual defect. Such deformity accompanies idiocy, not only in the shape of paralysis, and the wasting and contortions consequent on this, but in absence, imperfection, or reduplication of limbs or organs, ranging from simple webbing of the fingers or supernumerary digits to the most hideous malformations. I cannot now, however, enter on this. In 571 cases of idiocy collected by Dr. Howe, twenty-one were blind and had deformed eyes, twelve were deaf, twenty-three had deformity of mouth and nose, fifty-four deformed hands and feet, and ninety-six were paralyzed in some parts; and every asylum for the imbecile and idiotic affords numerous instances of this kind, which add not a little to the painful aspect of the inmates.

The practical conclusions which we may, I think, draw from the facts I have placed before you are—

1st. That the marriage of persons who are or have been insane, or who come of families in which insanity is known to exist in a pronounced form, should—except under special circumstances—be discouraged, as likely, in addition to the dangers of direct heredity, and the production of progeny apt to develop insanity, to produce idiotic or imbecile children.

2nd. That the intermarriage of persons from neurotic or insane families, and the marriage of near kin, especially when there is mental peculiarity of any kind, should be discountenanced in every possible way, as almost certain to result in insane or idiotic offspring; and

3. That we, as medical men, have a duty to perform in this matter by pointing out the evils likely to result from such unions.

No.	Relationship of parents.	Total number of children.	No. of imbecile or idiotic children.	Insane relations.	Remarks.
	Group 1.				
1	Nothing known	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Nothing known....	Imbecile only in slight degree.
2	Do	2 (2 m.)	2 (2 m.)	do.	Do. do.
3	Do	2 (1 m. 1 f.)	2 (1 m. 1 f.)	do.	Imbecile.
		6 4 2	6 4 2		
	Group 2.				
4	None	8 (3 m. 5 f.)	3 (2 m. 1 f.)	None as far as could be ascertained.	All badly imbecile.
		8 3 5	3 2 1		
	Group 3.				
5	None	4 (2 m. 2 f.)	4 (2 m. 2 f.)	Insanity on both sides. Paternal grand-mother and uncle, and maternal uncle.	Imbecile. All three insane relations were in Gladesville, one for sixteen, and one for twenty-two years.
6	Do	3 (1 m. 2 f.)	2 (2 f.)	Father insane, mother weak-minded and epileptic.	Imbecile. Father cripple, brother a dwarf.
7	Do	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Father insane, mother weak-minded.	Imbecile slightly.
8	Do	4 (3 m. 1 f.)	2 (1 m. 1 f.)	A paternal cousin, two maternal uncles, and one maternal cousin.	Imbecile badly.
9	Do	5 (3 m. 2 f.)	2 (2 f.)	Paternal cousin, mother imbecile.	Imbecile badly. Both sisters and three brothers have supernumerary fingers and toes; two of brothers are somewhat weak-minded.
		18 10 8	12 4 8		
10	Do	6 (4 m. 2 f.)	2 (2 m.)	Insanity on one side only. Maternal grand-father.	Imbecile.
11	Do	3 (2 m. 1 f.)	2 (1 m. 1 f.)	Mother........	One idiotic, one imbecile, mother in Gladesville.
12	Do	2 (1 m. 1 f.)	2 (1 m. 1 f.)	Mother	Imbecile.
13	Do	3 (2 m. 1 f.)	2 (1 m. 1 f.)	Father	Imbecile.
14	Do	5 (3 m. 2 f.)	2 (2 f.)	Mother	Idiotic.
15	Do	5 (3 m. 2 f.)	2 (2 f.)	Maternal grand-mother, and six maternal uncles.	Idiotic.
16	Do	2 (1 m. 1 f.)	2 (1 m. 1 f.)	....	Idiotic.
		26 16 10	14 6 8		
	Group 4.				
17	Brother and sister	7 (4 m. 3 f.)	3 (3 m.)	....	Badly idiotic. Father and mother and remaining members of family described as very simple-minded.
18	Do	7 (3 m. 4 f.)	3 (2 m. 1 f.)	....	Badly idiotic. Father a drunkard, mother bed-ridden and paralysed, both described as dull in intellect
19	Do	3 (3 m.)	3 (3 m.)	....	Badly idiotic. Parents described as uneducated, low in type, and below par in intellect.
20	1st cousins	4 (3 m. 1 f.)	4 (3 m. 1 f.)	Maternal cousin ..	Imbecile.
21	Do	3 (2 m. 1 f.)	2 (2 m)	Several cousins	Idiotic. Parents not noticeably peculiar.
		24 15 9	15 13 2		
	Total ..	82 48 34	50 29 21		

APPENDIX.

ABSTRACT OF THE METEOROLOGICAL OBSERVATIONS TAKEN AT THE SYDNEY OBSERVATORY.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East
Height above Mean Sea-level, 146 feet.

JANUARY, 1885.—GENERAL ABSTRACT.

Barometer	Highest Reading... ...	30·129 on the 28th.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·446 on the 17th.
	Mean Height	29·807

(Being 0·042 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	13·5 lbs. on the 8th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	E.N.E.

(Prevailing direction during the same month for the preceding 26 years, N.E.)

Temperature	Highest in the Shade ...	96·7 on the 9th and 31st.
	Lowest in the Shade ...	56·0 on the 28th.
	Greatest Range	31·1 on the 31st.
	Highest in the Sun ...	154·2 on the 9th.
	Lowest on the Grass ...	50·7 on the 29th.
	Mean Diurnal Range ...	13·7
	Mean in the Shade ...	72·5

(Being 1·2 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	96·0 on the 24th.
	Least	30·0 on the 9th.
	Mean	72·1

(Being 0·4 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days	19 rain and 4 dew.
	Greatest Fall	1·560 inches on the 12th.
	Total Fall...	2·055 „ 65 ft. above ground.
		3·925 „ 15 in. above ground.

(Being 0·388 inch greater than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	4·683 inches.
Electricity ...	Number of Days Lightning	7
Cloudy Sky ...	Mean Amount	7 5
	Number of Clear Days ...	0
Meteors ...	Number observed ...	0

Remarks.

Mean barometer at Sydney has been slightly above the average, and the temperature has been 1·2 greater than the average. Nearly 4 inches of rain fell in Sydney. In the Colony, generally, the early part of the month was very dry, but about the middle light rains fell at many places, and on 24th and following days one of the finest rain storms on record here passed over the Colony. Coming in on the N.W. corner, it spread out over the greater part of the Colony; west of the Darling from 9 to 11 inches fell, other places not so heavy; the rain fell steadily in from 30 to 40 hours, and did not cause floods.

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GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

FEBRUARY, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·026 on the 22nd.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·393 on the 7th.
	Mean Height	29·755

(Being 0·050 inch less than that in the same month on an average of the preceding 26 years.

Wind	Greatest Pressure ...	12·5 lbs. on the 20th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years, S.

Temperature	Highest in the Shade ...	92·1 on the 20th.
	Lowest in the Shade ...	57·7 on the 10th.
	Greatest Range	22·4 on the 20th.
	Highest in the Sun ...	143·9 on the 20th.
	Lowest on the Grass ...	46·3 on the 9th.
	Mean Diurnal Range ...	13·8
	Mean in the Shade ...	72·7

(Being 1·9 greater than that of the same mouth on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	97·0 on the 17th.
	Least	41·0 on the 9th.
	Mean	71·5

(Being 2·9 less than that of the same month on an average of the preceding 26 years.

Rain	Number of Days	9 rain and 5 dew.
	Greatest Fall	0·377 inch on the 13th.
	Total Fall... ...	1·452 „ 65 ft. above ground.
		1·605 „ 15 in. above ground.

(Being 4·031 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	3·282 inches.
Electricity ...	Number of Days Lightning	6
Cloudy Sky ...	Mean Amount	6·0
	Number of Clear Days ...	2
Meteors	...Number observed ...	0

Remarks.

Barometer this month was 0·050 below the average, and the temperature 1·9 greater than the average. Only 1·605 rain fell in Sydney, being 4 inches below the average fall for this month. On the 20th the wind pressure rose to 12·5 lbs. on the square foot.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, $10^h\ 4^m\ 50{\cdot}81^s$; MAGNETIC VARIATION ° 35′ 37″ East
Height above Mean Sea-level, 146 feet.

MARCH, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·064 on the 22nd.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·297 on the 12th
	Mean Height	29·822

(Being 0·070 inch less than that in the same month on an average of the preceding years.

Wind	Greatest Pressure ...	8·4 lbs. on the 12th, 16th, and 19th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years N

Temperature	Highest in the Shade ...	92·0 on the 12th.
	Lowest in the Shade ...	56·6 on the 1st and 2nd.
	Greatest Range	25·5 on the 17th.
	Highest in the Sun ...	139·1 on the 12th.
	Lowest on the Grass ...	48·9 on the 15th.
	Mean Diurnal Range ...	13·1
	Mean in the Shade ...	69·2

(Being 0·1 less than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	95·0 on the 20th.
	Least	25·0 on the 12th.
	Mean	71·6

(Being 4·4 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days	15 rain and 5 dew.
	Greatest Fall	0·890 inches on the 1st.
	Total Fall...	0·575 „ 65 ft. above ground. 1·899 „ 15 in. above ground.

(Being 2·938 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	2·251 inches.
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	5·4
	Number of Clear Days ...	4
Meteors ...	Number observed ...	0

Remarks.

Mean barometer read 0·070 inch above the average; prevalent winds were light north-easterly. Mean temperature came very close to the average, but on the 12th the shade temperature rose to 92·0. Rainfall, only 1·899 inch, or nearly 3 inches below the average. In the country, generally, the rainfall for March has been very low; at a few places, however, in the Northern districts good rain fell, but only over a limited area. In the Southern districts many places have had another very dry month. Still the total rainfall of first three months of 1885 compare favourably with that of the same period in 1884, owing to the very heavy rains in January.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ E.
Height above Mean Sea-level, 146 feet.

APRIL, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·271 on the 28th.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading... ...	29·636 „ on the 15th.
	Mean Height	30·052.

(Being 0·120 inch greater than that in the same month on an average of the preceding 26 y .

Wind	Greatest Pressure ...	8·4 lbs. on the 17th and 27th.
	Mean Pressure	0·6 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	77·3 on the 14th.
	Lowest in the Shade ...	47·9 on the 29th.
	Greatest Range	21·1 on the 29th.
	Highest in the Sun ...	125·3 on the 11th.
	Lowest on the Grass ...	43·1 on the 29th.
	Mean Diurnal Range ...	12·4
	Mean in the Shade ...	64·6

(Being 0·2 greater than that of the same month on an average ot the preceding 26 years.)

Humidity ...	Greatest Amount ...	91·0 on the 14th.
	Least	53·0 on the 15th.
	Mean	74·6

(Being 3·0 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days	12 rain and 8 dew.
	Greatest Fall	0·391 inches on the 18th.
	Total Fall	0·739 „ 65 ft. above ground.
		1·401 „ 15 in. above ground.

(Being 5·351 inch less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	3·240 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	6·3
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

The Barometer this month has again read above the average this time by 0·120 inch, the temperature being about the average. The month has been very dry in Sydney, and in the country the rain record is a very poor one. Many of the stations report less than an inch, some less than half an inch. In the Northern coast districts good rains fell. A little rain fell in the North-western districts, and some along the Murray; but the want of rain has not been so much felt as it would have been but for the small quantity of wind which passed by.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

MAY, 1885.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·226 on the 11th.
	Lowest Reading	29·667 on the 7th.
	Mean Height	29·999

(Being 0·001 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	8·4 lbs. on the 7th.
	Mean Pressure	0·2 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.S.W.

(Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	77·3 on the 5th.
	Lowest in the Shade ...	46·2 on the 20th.
	Greatest Range	23·1 on the 15th.
	Highest in the Sun ...	118·2 on the 5th.
	Lowest on the Grass ...	38·1 on the 20th.
	Mean Diurnal Range ...	15·5
	Mean in the Shade ...	60·0

(Being 1·5 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	92·0 on the 6th.
	Least	39·0 on the 22nd.
	Mean	72·4

(Being 3·7 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days... ...	5 rain and 18 dew.
	Greatest Fall	0·058 inch on the 8th.
	Total Fall... ...	0·045 „ 65 ft. above ground.
		0·214 „ 15 in. above ground.

(Being 5·032 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	2·830 inches.
Electricity ...	Number of Days Lightning	0
Cloudy Sky ...	Mean Amount	4·8
	Number of Clear Days ...	3
Meteors ...	Number observed ...	0

Remarks.

Barometer has again been nearly a tenth of an inch above the average; and the temperature also has been high—1·5 greater than the average. Excepting the Port Macquarie district, the rain this month has been very light throughout the Colony; nearly everywhere less than an inch has been recorded. At Sydney the record is only 0·214 inch, and in the district all round the city the want of water is getting serious.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

JUNE, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·297 on the 9th.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·572 on the 15th.
	Mean Height	29·938

(Being 0·016 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	10·1 lbs. on the 16th.
	Mean Pressure	0·8 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	69·7 on the 1st.
	Lowest in the Shade ...	40·6 on the 30th.
	Greatest Range	19·7 on the 3rd.
	Highest in the Sun ...	108·8 on the 16th.
	Lowest on the Grass ...	34·4 on the 3rd.
	Mean Diurnal Range ...	11·2
	Mean in the Shade ...	54·4

(Being 0·1 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount... ...	100·0 on the 12th, 18th, 22nd, 23rd, and 24th.
	Least	44·0
	Mean	76·1

(Being 0·4 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days... ...	16 rain and 5 dew.
	Greatest Fall	4·845 inches on the 24th.
	Total Fall	12·649 „ 65 ft. above ground.
		16·296 „ 15 in. above ground.

Being 11·110 inches greater than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	1·892 inches.
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	5·0
	Number of Clear Days ...	7
Meteors ...	Number observed ...	0

Remarks.

Barometer and thermometer this month have been near the average; and the rainfall at Sydney very heavy—16·296 inches. On the coast about Sydney very heavy rain has fallen, but only over a very limited area along other parts of the coast, and also on the mountains inland the fall has been moderate; but some places have had a very dry month, particularly in the south-west of the Colony, where at one station the total rainfall for the six first months of the year was only 3·43 inches.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East
Height above Mean Sea-level, 146 feet.

JULY, 1885.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading	30·358 on the 30th.
	Lowest Reading	29·615 on the 26th.
	Mean Height	30·037

(Being 0·090 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	10·1 lbs. on the 28th.
	Mean Pressure	0·4 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	64·7 on the 25th.
	Lowest in the Shade ...	42·6 on the 20th.
	Greatest Range	19·7 on the 11th.
	Highest in the Sun ...	107·0 on the 26th.
	Lowest on the Grass ...	35·3 on the 3rd.
	Mean Diurnal Range ...	12·0
	Mean in the Shade ...	52·8

(Being 0·4 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	100·0 on the 18th, 22nd, and 30th.
	Least	49·0 on the 26th.
	Mean	80·7

(Being 5·6 greater than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days... ...	20 rain and 6 dew.
	Greatest Fall	2·250 inches on the 23rd.
	Total Fall... ...	5·391 ,, 65 ft. above ground.
		7·451 ,, 15 in. above ground.

(Being 3·346 inches greater than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	1·669 inches.
Electricity ...	Number of Days Lightning	0
Cloudy Sky ...	Mean Amount	5·6
	Number of Clear Days ...	5
Meteors ...	Number observed ...	0

Remarks.

Mean barometer this month was 0·090 above the average, with prevailing westerly winds. The month of July has been a very dry one in all parts of the Colony except the coast districts from Bodalla to Manning River; the heaviest fall was recorded in and about Sydney, where it amounted to 7·45 inches. Of the 414 stations reporting rain, 270 reported less than half an inch.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

AUGUST, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·249 on the 25th.
At 32° Faht., but not corrected to sea-level.	Lowest Reading	29·419 on the 14th.
	Mean Height	29·906

(Being 0·028 inch less than that in the same month on an average of the preceding 26 years.)

Wind... ...	Greatest Pressure ...	25·9 lbs. on the 7th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	1
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	81·9 on the 29th.
	Lowest in the Shade ...	42·8 on the 13th and 25th.
	Greatest Range	30·7 on the 29th.
	Highest in the Sun ...	124·0 on the 30th.
	Lowest on the Grass ...	33·2 on the 13th.
	Mean Diurnal Range ...	17·0
	Mean in the Shade ...	57·0

(Being 2·0 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	98·0 on the 2nd.
	Least	32·0 on the 14th and 30th.
	Mean	63·6

(Being 8·4 less than that of the same month on an average of the preceding 26 years.

Rain	Number of Days	6 rain and 6 dew.
	Greatest Fall	0·011 inch on the 25th.
	Total Fall...	0·006 „ 65 ft. above ground. 0·040 „ 15 in. above ground.

(Being 2·910 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	2·002 inches.
Electricity ...	Number of Days Lightning	1
Cloudy Sky ...	Mean Amount	2·7
	Number of Clear Days ...	12
Meteors ...	Number observed ...	0

Remarks.

On the 7th of August a heavy S.S.W. gale blew at Sydney for 8 hours, and the greatest pressure recorded during the time was 25·9 lbs. on the square foot. The rainfall this month has been very light; over great part of the Colony less than 0·50 has fallen, and in and near Sydney the drought has been very severe, the fall being less than in any previous August during 27 years. At a few of the stations moderate rain fell, *i.e.*, from 1 to 2 inches, but at no station has the rainfall been sufficient, after the continued dry weather, to give a good supply of water and grass.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

SEPTEMBER, 1885.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading	30·333 on the 7th.
	Lowest Reading	29·518 on the 26th.
	Mean Height	29·965

(Being 0·088 inch greater than that in the same month on an average of the preceding 26 years.

Wind	Greatest Pressure ...	11·0 lbs. on the 27th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years, W.)

Temperature	Highest in the Shade ...	80·5 on the 5th.
	Lowest in the Shade ...	45·8 on the 7th.
	Greatest Range	29·2 on the 4th.
	Highest in the Sun ...	126·6 on the 22nd.
	Lowest on the Grass ...	36·1 on the 4th.
	Mean Diurnal Range ...	16·5
	Mean in the Shade ...	61·7

(Being 3·0 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	96·0 on the 23rd.
	Least	25·0 on the 4th.
	Mean	65·0

(Being 5·0 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days	8 rain and 6 dew.
	Greatest Fall	0·185 inch on the 27th.
	Total Fall...	0·389 „ 65 ft. above ground.
		0·667 „ 15 in. above ground.

(Being 2·580 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	2·502 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	4·5
	Number of Clear Days ...	5
Meteors ...	Number observed ...	0

Remarks.

The mean barometer this month was 0·088 inch above the average; and the mean temperature at Sydney 3·0 above the average. Over the greater part of the Colony the September rains were wanting, and even in the few favoured spots where there has been some rain it has been by no means equal to requirements; indeed, it may be said that rain is badly wanted all over the Colony just now, and in some places the continued dry weather is becoming serious. During this month the great majority of stations had less than 2 inches. In the Upper New England they had from 3 to 4 inches, in parts of Riverina about the same. Comparing the total rainfall for the last nine months of 1885 with that for the corresponding period of 1884, it appeared that the fall for 1885 is, in the majority of places, in excess of 1884.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

OCTOBER, 1885.—GENERAL ABSTRACT.

Barometer ... At 32° Faht., but not corrected to sea-level.	Highest Reading... ...	30·313 on the 15th.
	Lowest Reading	29 516 on the 22nd.
	Mean Height	29·986

(Being 0·157 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	11·0 lbs. on the 22nd.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years, N.E.)

Temperature	Highest in the Shade ...	90·3 on the 31st.
	Lowest in the Shade ...	46·7 on the 13th.
	Greatest Range	28·1 on the 31st.
	Highest in the Sun ...	144·8 on the 22nd.
	Lowest on the Grass ...	40·8 on the 5th.
	Mean Diurnal Range ...	14·7
	Mean in the Shade ...	64·9

(Being 1·7 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount... ...	97·0 on the 12th.
	Least	42·0 on the 22nd.
	Mean	71·8

(Being 2·6 greater than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days	10 rain and 6 dew.
	Greatest Fall	0·983 inch on the 13th.
	Total Fall...	0·856 inches 65 ft. above ground.
		1·406 „ 15 in. above ground.

(Being 1·694 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	3·238 inches.
Electricity ...	Number of Days Lightning	2
Cloudy Sky ...	Mean Amount	5·7
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

Barometer this month has again been high—0·157 above the average; and the temperature 1·7 above the average. October must be classed as another dry month. Of the 493 stations reporting, 353 had less than 1 inch of rain, 113 over 1 inch and less than 2 inches, and only 27 had over 2 inches, and most of these, as usual, on the coast. Such rains are in the majority of cases quite inadequate to supply the ordinary demand for water supply and vegetation; but in the aggravated drought affecting a large portion of the Colony, such a small rainfall affords no relief. On the 26th of this month the Darling stopped running at Bourke; it had been dry at Walgett for some time before, and there were indications of still greater dryness to come in that part of the Colony.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

NOVEMBER, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·186 on the 2nd.
At 32° Faht., but not corrected to sea-level.	Lowest Reading	29·506 on the 5th.
	Mean Height	29·886

(Being 0·084 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	32·0 lbs. on the 5th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 26 years, S.)

Temperature	Highest in the Shade ...	97·6 on the 5th.
	Lowest in the Shade ...	52·4 on the 12th.
	Greatest Range	33·4 on the 5th.
	Highest in the Sun ...	154·4 on the 5th.
	Lowest on the Grass ...	40·1 on the 12th.
	Mean Diurnal Range ...	14·8
	Mean in the Shade ...	66·7

(Being 0·3 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	93·0 on the 26th.
	Least	24·0 on the 5th.
	Mean	67·1

(Being 2·6 less than that of the same month on an average of the preceding 26 years.)

Rain	Number of Days... ...	10 rain and 3 dew.
	Greatest Fall	0·500 inch on the 7th.
	Total Fall...	*1·190 inches 65 ft. above ground. *1·013 „ 15 in. above ground.

(Being 2·153 inches less than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	4·518 inches.
Electricity ...	Number of Days Lightning	4
Cloudy Sky ...	Mean Amount	5·7
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

The barometer this month has been again above the average by 0·084. On the 5th of the month a very heavy W.N.W. gale blew, and the greatest pressure recorded was 32 lbs. on the square foot at 7 p.m. The Darling was not running this month between Walgett and Menindie, and the country districts generally are suffering from drought.

* Contains some which fell on the afternoon of November 30, which in the other gauge was recorded on December 1st.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 50·81s; MAGNETIC VARIATION, 9° 35′ 37″ East.
Height above Mean Sea-level, 146 feet.

DECEMBER, 1885.—GENERAL ABSTRACT.

Barometer ...	Highest Reading... ...	30·123 on the 18th.
At 32° Faht., but not corrected to sea-level.		
	Lowest Reading	29·623 on the 23rd.
	Mean Height	29·887

(Being 0·154 inch greater than that in the same month on an average of the preceding 26 years.)

Wind	Greatest Pressure ...	10·1 lbs. on the 24th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	E.

(Prevailing direction during the same month for the preceding 26 years, N.E. and E.N.E.)

Temperature	Highest in the Shade ...	93·8 on the 8th.
	Lowest in the Shade ...	56·6 on the 1st and 2nd.
	Greatest Range	27·0 on the 8th.
	Highest in the Sun ...	150·0 on the 8th.
	Lowest on the Grass ...	49·4 on the 1st.
	Mean Diurnal Range ...	13·2
	Mean in the Shade ...	70·8

(Being 1·1 greater than that of the same month on an average of the preceding 26 years.)

Humidity ...	Greatest Amount ...	99·0 on the 12th.
	Least	37·0 on the 9th.
	Mean	72·5

(Being 3·4 greater than that of the same month on an average of the preceding 26 years.)

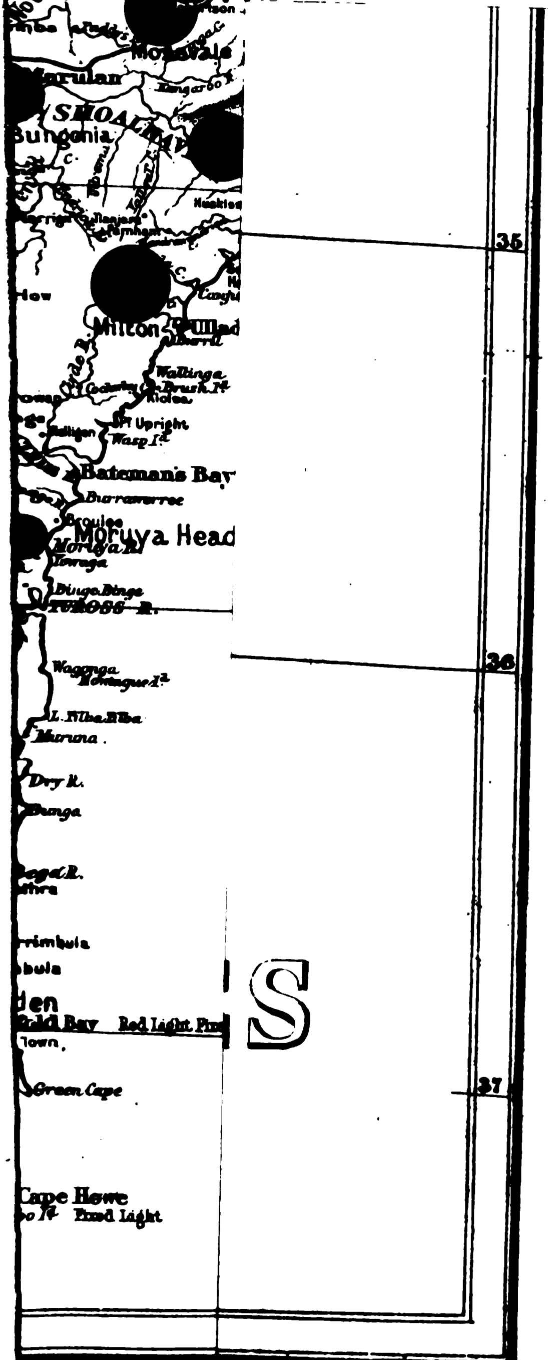
Rain	Number of Days... ...	15 rain and 7 dew.
	Greatest Fall	0·928 inch on the 14th.
	Total Fall...	2·044 inches 65 ft. above ground. 3·991 „ 15 in. above ground.

(Being 1·875 inches greater than that of the same month on an average of the preceding 26 years.)

Evaporation	Total Amount	4·407 inches.
Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	6·1
	Number of Clear Days ...	2
Meteors ...	Number observed ...	0

Remarks.

Barometer this month has been 0·154 above the average, and the temperature 1·1 above the average. The rainfall at Sydney, 3·991 inches, represents fairly the fall in the Sydney district. Along the coast northwards it was heavier. In New England, 3½ to 7½ inches fell. West of the Darling, and along the Queensland Border to New England, 2½ to 9½ inches, very many stations having 4 or 5 inches. Between the Darling, Macquarie, and Lachlan, 2 to 3½ inches—other parts about 2 inches. Generally the effect of these December rains has been equal to 10 per cent. of the average rainfall—bring the total fall for 1885 up to 91 per cent. of the average.



Marulan
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Pt Upright
Wasp I.
Broulee
Moruya Head
Moruya R.
Tuross R.
Wagonga
Montague I.
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